LOCAL MAN

↳ CHECK HAYES
559-1037
OR
849-5941

BOB BISHOP IS AT ANDROS. FAX ORDER TO BOB BISHOP
510-849-5849

510-849-5700

OEM User Manual

- - -

Andros 200 Series
Gas Emission Analyzer

- - -

July 1984

Read this page first.

The chapters of this manual tell you --

1. What the product is
2. About this manual, who it's for, how to use it
3. What the product design does in general
4. How the product works
5. How the product works in its test mode
6. How to test the product
7. How to do maintenance and servicing
8. How to get replaceable parts
9. How to get training and administrative information
10. About information that is commonly used by experienced technicians

Appendices provide specialized information including schematics and a glossary.

An index of subjects is at the back of the manual.

vvvv

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Notice
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Overview

The Andros 200 Series Gas Analyzer is an infrared and electronics subsystem. It is the key sensor component of in automotive exhaust emission analyzer equipment. For convenience in this manual we will refer to it as the Bench 200.

Bench 200 is used by a variety of manufacturers and service companies of gasoline motors.

Gases measured by the Bench 200 are carbon dioxide (CO2), hydrocarbons (HC), and carbon monoxide (CO).

Bench 200 has two models - Model 216B/E and Model 256B/E. They differ in the number of gases they analyze, the California Bureau of Automotive Repair (BAR) standards that apply to their use, and whether for domestic (B) or European (E) markets:

	Measures:			Requirements:		
	CO	HC	CO2	BAR 74	BAR 80	BAR 84
Model 216B/E	x	x		x	x	
Model 256B/E	x	x	x	x	x	x

1. History

Bench 200 was first introduced and has been proven in operation since 1980. The basic design has remained the same although refinements have been made. The main differences are in the 036 and the 046 processor board. Where differences are significant, they will be noted in this manual.

Bench 200 has remained basically the same since it was first manufactured in 1980. It has had design enhancements. Latest versions have the 046 processor PCB (printed circuit board) and motor. Except where noted in the manual, the operational characteristics are the same for either processor.

All warranty/nonwarranty return units are sent to customers with revisions/modifications necessary to meet necessary minimum production requirements necessary to comply with current BAR, EPA, TUV, etc., requirments.

2. Design

Bench 200 design uses the following major design elenments:

- Non-dispersive Infrared (NDIR) source architecture
- Temperature-controlled infrared radiation (IR) filters and detector
- Patented sample cell configuration
- Signal error correction
- Autosynchronous detection/demodulation

3. Bench 200 Features

Bench 200 features include the following:

... concerning performance stability ...

- High reliability IR source
- Temperature stabilization in filters and IR detector
- Compensation for changes in IR source and detector characteristics
- Constant speed filter motor

... concerning economy of design ...

- One mechanical part - direct drive motor
- Single energy path
- Automatic synchronizer ciruit
- Modular design
- Simplified calibration controls

4. How Model Series 200 Is Built and Tested

Andros production of Bench 200 includes thorough production engineering, component specifications and purchasing, fabrication of selected parts, assembly, quality assurance, testing, and shipping.

Aspects of special interest to the original equipment manufacturer (OEM) user are parts selection, quality assurance, testing, shipping, and customer service.

1. Parts

Parts for Bench 200 fall into several categories. They may be parts --

- o made to strict Andros specifications and available only through Andros
- o meeting strict Andros specifications, the parts are specificially required for the Bench 200, but are available from electronics distributors as well as from Andros
- o meeting general electronic industry standards, and available from electronics parts distributors as well as from Andros

All parts for the Bench 200 are available from Andros.

Andros tests all parts prior to assembly or resale as replacement parts.

2. Quality Assurance

Bench 200 is the subject of an aggressive quality assurance program that ranges from parts specification to final production and shipping.

4. How Model Series 200 Is Built and Tested (cont'd)

3. Factory Test

Factory test includes three major operations: the Bringup Test, Instrumentation Drift Test, and Final Test.

1. Bringup Test

In the Bringup Tests, Andros technicians perform preliminary performance checks on all sub assemblies and final output of the Bench 200.

The Bringup is similar to the test procedures that the OEM does, with several exceptions. One exception is that the tolerances are considerably stricter than those for OEM operations.

2. Instrumentation Drift Test

Instrumentation Drift Tests are a group of computer-measured tests that check the stability of Bench 200 instrumentation in both ambient and elevated temperature environments.

These tests check the Bench 200 overall stability (amount of zero drift against nominal specifications).

3. Final Test

Final Test calculates Propane Equivalency Factor. (PEF). This factor is applied by the user calibration when using propane instead of hexane for calibration.

Final Testing also measures the interference among the three gases (crosstalk). From these tests, factory adjustments are made to correct for crosstalk error.

4. How Model Series 200 Is Built and Tested (cont'd)

4. Shipping

Shipping and packaging are important to electronic instruments such as Bench 200. Whether shipped in small or large numbers, the Bench 200 packaging is well-designed and carefully implemented.

5. Sources of Information

You may obtain information about operating the Bench 200 from several sources:

- This User Manual with latest changes
- Product Bulletins that are sent out before changes to the User Manual
- Andros Bench 200 Training Classes
- Phone-in assistance from Andros Customer Service (see Chapter 7 - Maintenance and Repair)

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1. Who This Manual Is For

1. Primary Users

This manual is written primarily for service technicans who install Bench 200 in OEM gas analyzer systems. These primary users should be knowledgable about --

- o Electrical, heat, and gas safety
- o Basic procedures for assembly and disassembly of small electrical motors and PCBs
- o Use of digital multimeters
- o Use of oscilloscopes

This manual considers three types of service technicians who are defined by the following levels of maintenance they can perform:

1. Level 1 - acceptance checks and testing of complete units
2. Level 2 - Level 1, plus minor servicing and replacement of PCBs (detailed in Chapter 7 - Maintenance & Repair)
3. Level 3 - Level 2, plus component replacement and advanced testing

This manual is meant for service technicians performing Maintenance Levels 1 and 2. OEMs service technicians doing Level 3 work will need additional guidance.

Service technicians (Levels 1 and 2) need not be able to interpret electrical circuit schematics in order to use this manual. However, schematics and drawings are included in the appendices for those who may find them useful.

2. Other Users

Others besides service technicians may find this manual useful: OEM engineers, buyers, and those with a financial or general interest in Andros products.

2. Summary of Manual Contents

The manual is made up of seven major parts:

1. Introductory material - chapters about the general product, product features and production, typical manual users (Chapters 1-2)

2. Background - basic design, operating and testing principles of the Bench 200, explanation of each major assembly (Chapter 3-5)

3. Operating Procedures - testing procedures, maintenance, repair, troubleshooting, parts ordering (Chapter 6-8)

4. Administrative and Training Information - change information, copying the manual, product warranty, training (Chapter 9)

5. Quick Reference - useful excerpts from throughout the manual for day-to-day use (Chapter 10)

6. Appendices - specialized information on specifications, schematics, gas tables, etc.

7. Index

Each chapter and section normally have an overview of information that is to follow. Exceptions are when the chapter table of contents does that job adequately.

3. How To Use This Manual

This manual will be used differently according to each different type of reader. Readers are of three types:

1. Service technicians without prior Bench 200 experience
2. Service technicians with prior Bench 200 experience
3. The general reader

1. Service Technicians without Prior Bench 200 Experience

1. Check for your department's master manual to make sure your manual has the latest changes (see Appendix A to find the latest change that has been made to this manual)
2. Look over the entire table of contents
3. Before reading each chapter, look over the chapter table of contents and the chapter overview
4. Look over Section 5 (Terms and Symbols) and Section 6 (Notation)
5. Read Chapters 3, 4, and 5 for background information
6. Before beginning installations study Chapter 6 (Testing Procedures)
7. Before doing maintenance or repairs, study Chapter 7 (Maintenance and Repair)

3. How To Use This Manual (cont'd)

2. Service Technicians With Prior Bench 200 Experience

1. Check for your department's master manual to make sure your manual has the latest changes (see Appendix A to find the latest change that has been made to this manual)
2. Look over the entire table of contents: you will find that the manual organization is different and much information has been added to the old manual
3. Read the Overview in Chapter 6 (Testing Procedures)
4. Read over Section 3 (Detailed Testing Procedures) in Chapter 6 to check for differences from your present procedures
5. Look over Chapter 7 (Maintenance and Repair) to check for differences from your present procedures

3. General Readers

1. Look over the Detailed Table of Contents
2. Read Chapter 1 (Product Definition)
3. Read Section 1 (Who This Manual Is For)
4. Read the overview sections and tables of contents for each chapter of interest

4. Manual Updates

Updates to the User Manual will be issued from time to time.

Changes will be issued as page changes whenever possible.

Changes will be signalled by a bar in the column opposite text where changes have occurred.

When specific values are changed, the old value will be indicated by being crossed out.

Appendix A is a record of changes for this manual.

5. Terms and Symbols

Each special term used in this manual is normally explained when it first occurs. Additionally, a Glossary (Appendix G) is provided for reader convenience.

The following are excerpts from the Glossary:

Bench - common term for the assembly of infrared emitter, filters, prisms, sample cell, and detector used to analyze gases.

Bench 200 - a non-dispersive, single path bench; taken to include the electronics components needed to control and interface with a parent system.

AGC - Automatic Gain Control

CO2 - Carbon dioxide

CO - Carbon monoxide

CRO - cathode ray oscilloscope, oscilloscope

DLTP - Dark Level Test Point

DMM - Digital multimeter

HC - Hydrocarbons

Pedestal - Pulse measurement of output from the Selective Gain Amplifier (TP3)

6. Notations

This manual contains few special notations. Those that are used are described below.

The terms used for the product and each of its components are capitalized, for example, Bench 200, Motor, Motor Heatsink, Preamp.

ON means power is turned on.

OFF means power is turned off.

7. Access to Information

This manual has several devices to help the reader find information quickly:

- Short overall table of contents by chapters
- Move detailed overall table of contents by chapters and sections
- Table of contents for each chapter by section, subsection, and topic
- Chapter 10 - Quick Reference
- Index
- Illustrations normally face, or immediately follow, the page of text that the illustration explains
- Illustrations are labelled with part names, paragraph, or step number that is mentioned in the text
- Tables, lists, and illustrations have been used whenever possible. Text will be in the following pattern:

1. Chapter

Overview

Text xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxx
Text xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxx

1. Section

Section summary text xxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

1. Subject 1

1. Topic 1

Text xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxx
Text xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxx

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Overview

Bench 200 design is based on nine major design points:

1. Gas analyzers need to have the gas sample thoroughly mixed.

2. Every gas reacts uniquely to infrared energy by absorbing IR energy in particular wavelengths.

3. Bench 200 uses Non-dispersive Infrared (NDIR) technology. NDIR generates a series of IR pulses by which Bench 200 can analyze mixtures of multiple gases at one time.

4. The reaction of each gas to infrared energy can be converted to electrical signals. This is done by a photoelectric detector.

5. Gas analyzers must correct for IR signal distortion caused by changes in temperature, detector sensitivity, and residual radiation.

6. The non-dispersive infrared design of Bench 200 generates a series of composite signals. To identify the signal for each gas and to synchronize the system, Bench 200 uses a timing circuitry.

7. A connector is needed to get the output signal from Bench 200 to the parent system. Bench 200 also needs a connector to get calibration signals from the parent system.

8. IR absorption and electrical signals fluctuate with changes in temperature. Reliable measurement demands that temperatures be stabilized.

9. Calibration controls are needed.

Sections below describe these points in detail.

1. Sample Cell

Bench 200 uses a patented sample cell to contain the gases to be measured. It has two intake ports and one exhaust port. Its internal baffles and general design assure a smooth flow of gases that are thoroughly mixed.

2. Infrared Absorption by Gases

Each gas, as does every substance, blocks or absorbs infrared in particular wavelengths, which we measure in micrometers (mM). Wavelengths absorbed are unique for each gas.

Additionally, the amount of infrared absorbed varies with the amount of gas present.

Thus, the wavelength used and the amount of infrared energy absorbed will tell the type and concentration of gas present in a system.

The absorption spectra used by Bench 200 uses the following absorption spectra:

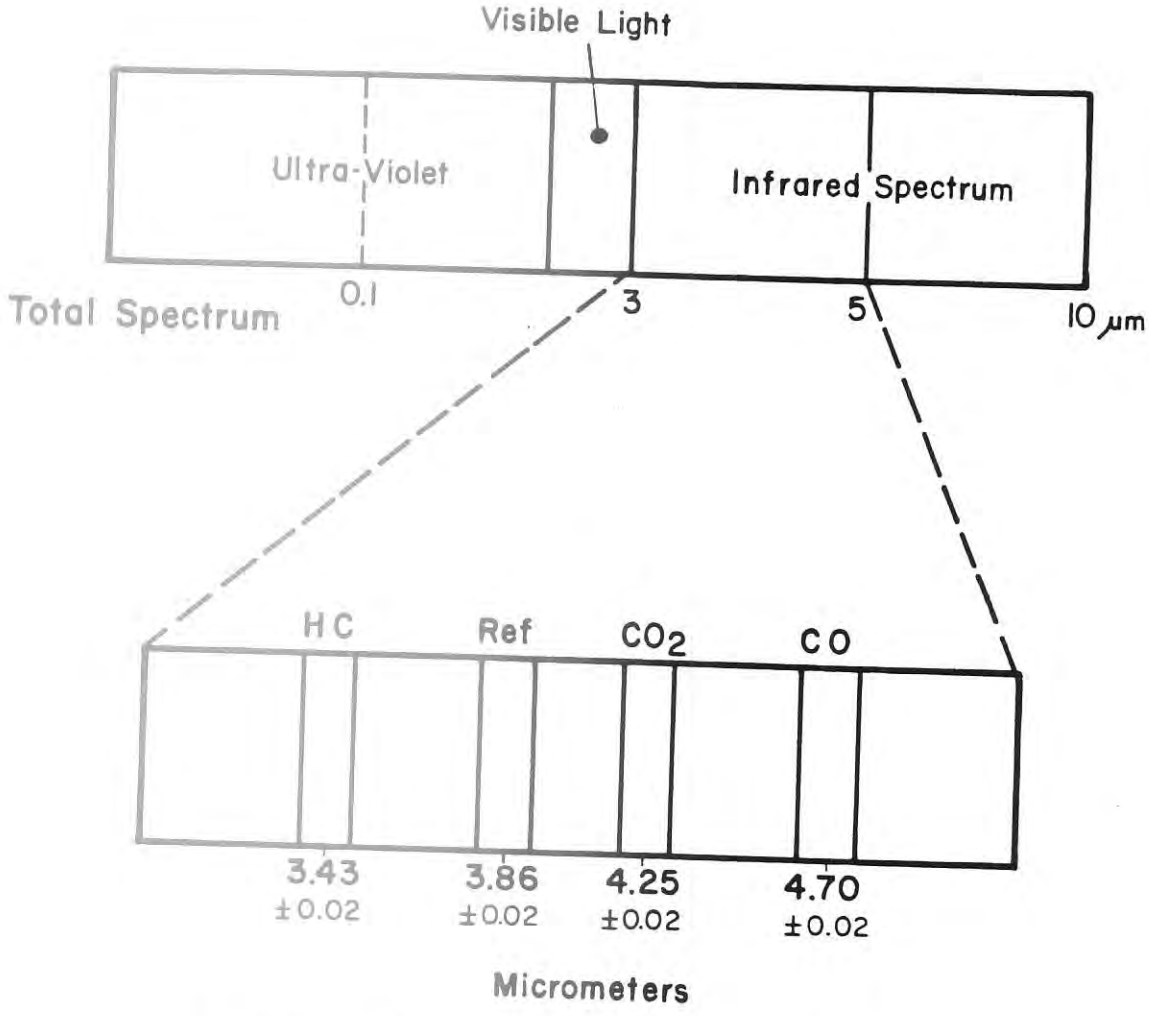
Carbon Dioxide (CO2)	- 4.23 to 4.27mM
Hydrocarbons (HC)	- 3.41 to 3.45mM
Carbon Monoxide (CO)	- 4.68 to 4.72mM
Reference*	- 3.83 to 3.87mM

Bench 200 uses a ceramic-sealed tungsten emitter to generate the infrared energy by which gases are analyzed.

Figure 3-1 shows how Bench 200 infrared energy has originated from the total energy radiation spectrum, then from the total infrared spectrum, and then from the individual energy bands of each gas.

Note: (*) The Reference signal is described in section 5, "Infrared Signal Correction"

Figure 3-1 -- Total Spectrum and Bench 200 Spectrum



Bench 200 - IR Bands - Filter Wheel

3. Non-dispersive Infrared Sensing

Multiple gas analyzers use one or the other of two sensing designs. These sensing methods are known as either --

- o Dispersive Infrared or
- o Non-dispersive Infrared (NDIR)

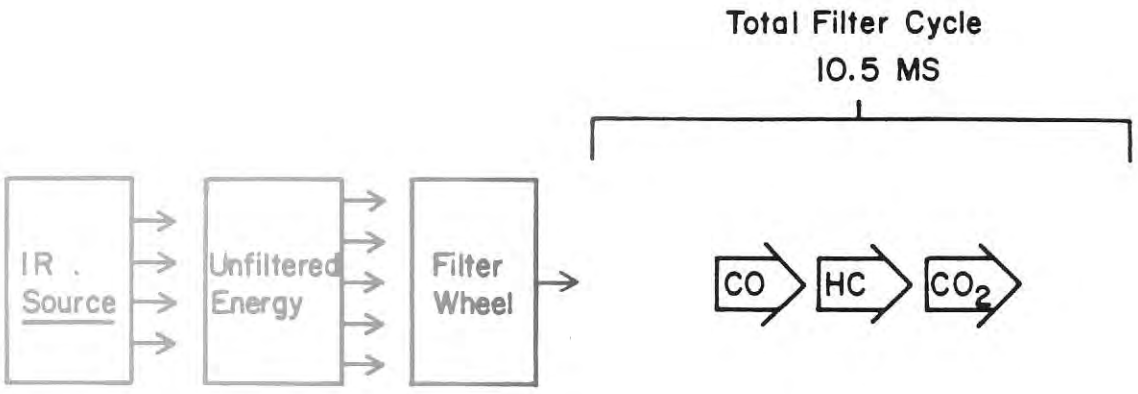
Dispersive infrared systems measure single multiple gases by first creating a separate path of infrared for each gas to be measured. This is done much like the school experiment that uses a prism to produce different beams of color.

In contrast to dispersive systems, Bench 200 NDIR sensing design uses filters to set up separate IR bands. Each gas is then measured during separate time periods. The filters, mounted in a rotating wheel, thus generate groups of infrared energy pulses.

These groups of IR pulses are then used to generate the electrical composite signals whose measurement shows the amount of gas present in the sample. The composite signals are demodulated into three separate output signals for each gas. This is done just prior to transmitting the signals to the parent system.

Figure 3-2 is a diagram that shows how the series of IR pulses are produced by the NDIR Filter Wheel.

Figure 3-2 -- Infrared Energy Generation



4. Infrared Detector

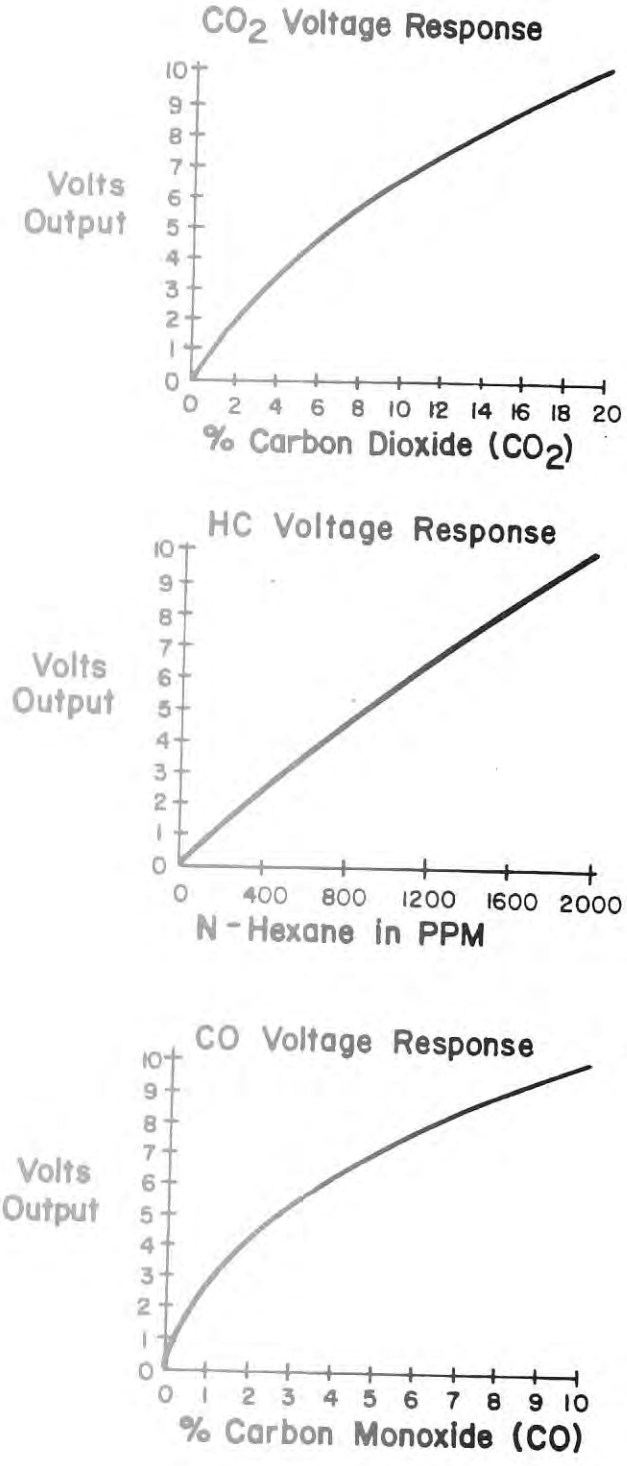
Infrared energy can be converted to electrical signals by a photoelectric detector.

The size of the signal generated varies directly with the strength of the infrared signal that hits the detector. This is so because the detector measures resistance caused by the signal the infrared generates. To summarize --

- the more gas present,
- the less infrared strikes the detector,
- the less electrical current is generated,
- the less the resistance, and
- the greater the signal produced by the Bench 200.

Figure 3-3 shows the voltage produced according to the quantity of gases present in a system.

Figure 3-3 -- Voltage Responses for CO2, HC, CO



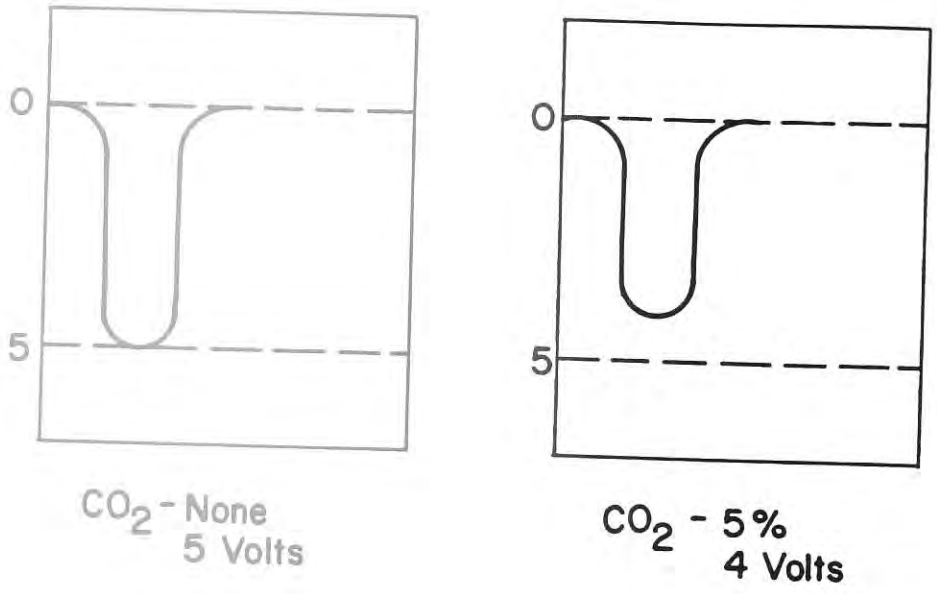
4. Infrared Detector (cont'd)

Figure 3-4 compares two sampling situations:

Figure 3-4 left pictorial shows a generalized picture of how an oscilloscope displays a signal measuring CO2 gas when CO2 is present.

Figure 3-4 right pictorial shows the display when the sample has 5% CO2 and produces a 4 volt signal.

Figure 3-4 -- Sampling Comparison



3. Infrared Signal Correction

Infrared signals may be distorted by changes in temperature, detector sensitivity, and residual radiation. Such signal distortion will happen no matter how well designed and built the analyzer may be.

Bench 200 solves this problem by making the Filter Wheel set up two additional time time periods. These time periods are in addition to those periods and IR pulses that are generated to measure gases.

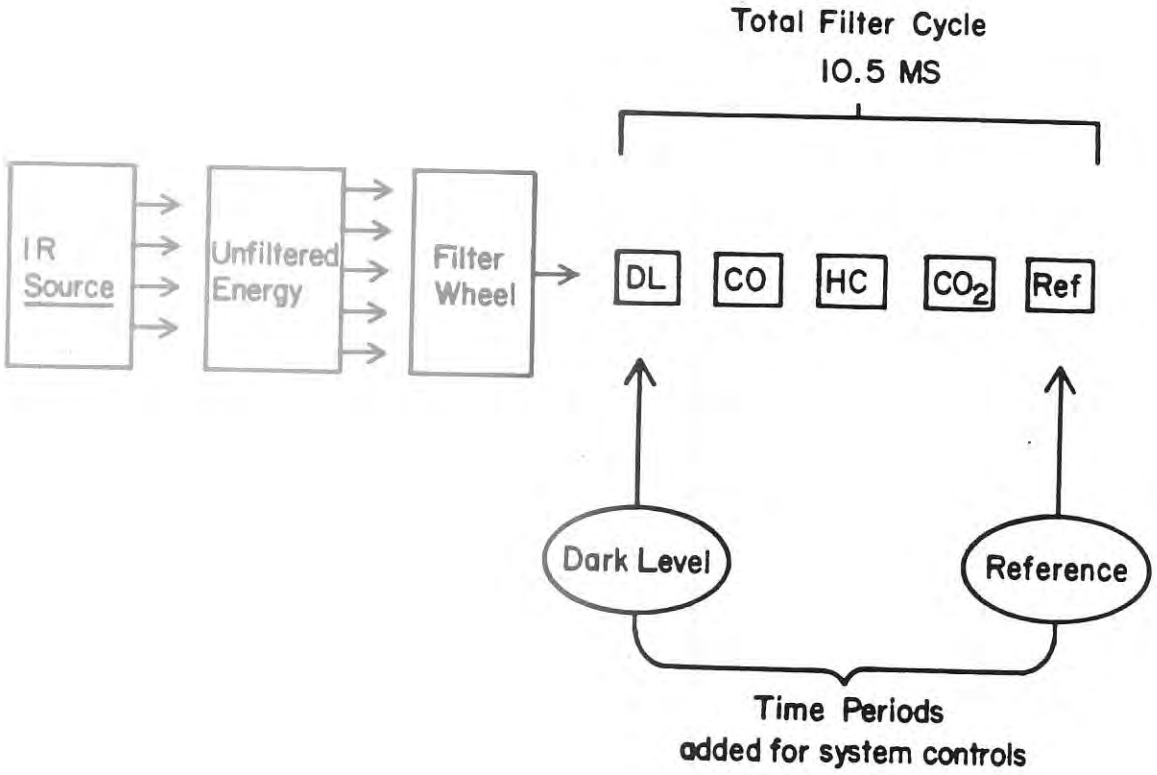
These two additional time periods are used for system control. The time periods and their purposes are as follows:

Dark Level - to reset the system measurement scale

Reference - to make corrections to the signal from each gas that is measured

Figure 3-5 is shows how the Dark Level and the Reference time periods are produced by the NDIR Filter Wheel, plus those for CO2, HC, and CO.

Figure 3-5 -- Reference and Dark Level Time Periods



5. Infrared Signal Correction (cont'd)

1. Dark Level Time Period

The Dark Level time period is set up because infrared signals may be read by Bench 200 even when there should be none. A common reason for this is residual radiation.

That means that the Bench 200 measurement scale sometimes is unable to settle down to zero from the time that one signal is measured until the time comes to measure the next signal.

Bench 200 uses the Dark Level time period to correct that situation. To do this, it has a Dark Level sector in the Filter Wheel that is completely blank. This blank sector blocks all IR pulses from the Source Element.

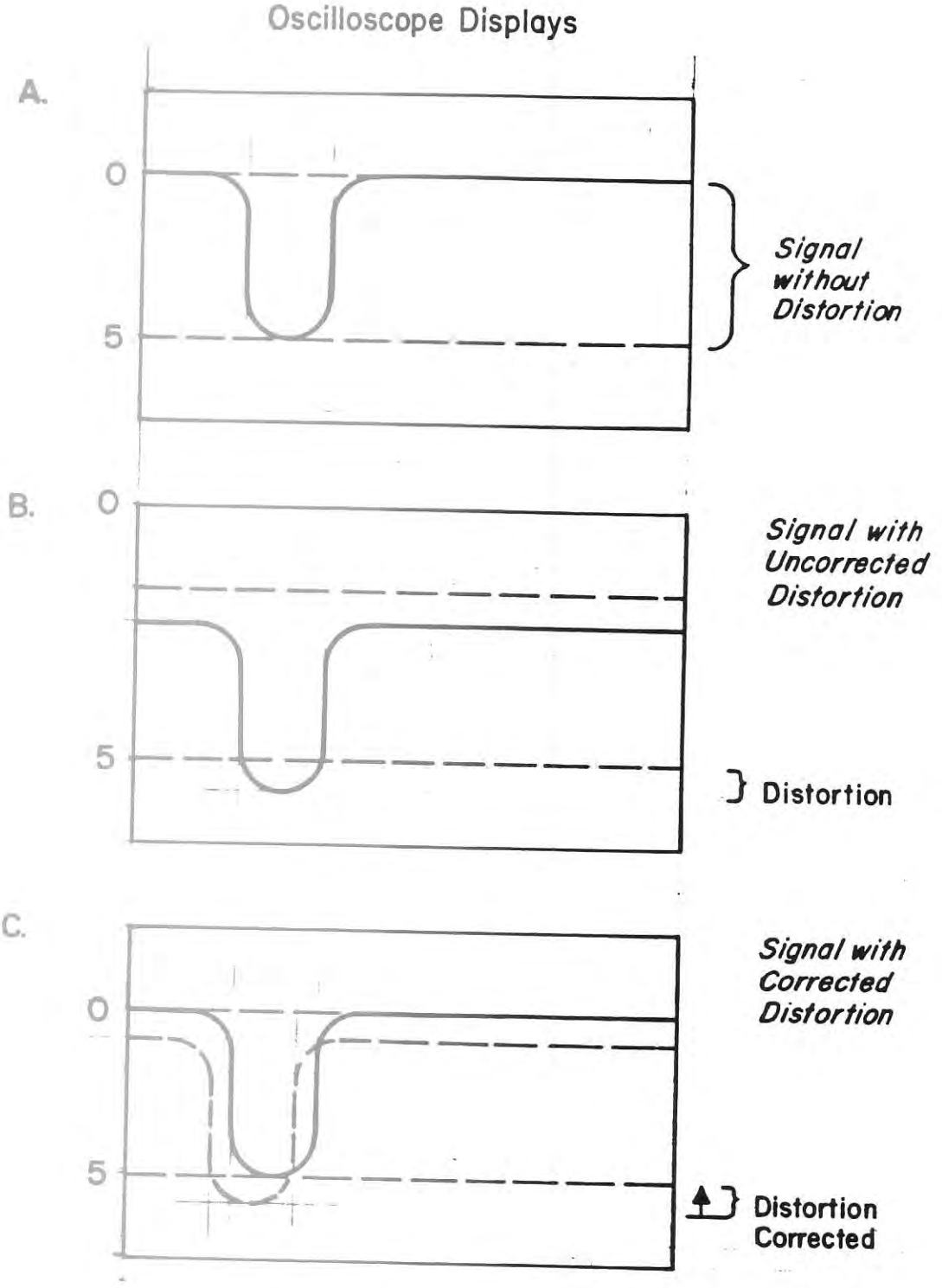
Bench 200 thus knows that during the Dark Level period the system should be at a 5 volt maximum. So Bench 200 counts the Dark Level period and resets the measurement scale to 0-5 volts scale at that moment. The next gas signals are then measured on a correct scale.

Figure 3-6A, B, C illustrates these points. Figure 3-6A shows a signal in a theoretically perfect system that has no signal distortion.

Figure 3-6B shows a signal in an actual system when distortion has been uncorrected.

Figure 3-6C shows a signal in an actual system after the measurement scale has been corrected.

Figure 3-6 -- Signal Correction (Dark Level)



5. Infrared Signal Correction (cont'd)

2. Reference Signal

The Reference time period and signal is set up because individual infrared signals for the measured gases can also be distorted.

Signals for each gas must be corrected. Bench 200 uses the Reference signal to make those corrections. To do this, it has a special Reference filter in the Filter Wheel.

Bench 200 uses a Reference filter that has a pass band where none of the measured gases will absorb infrared energy. Thus the Reference signal will not vary when CO2, HC, or CO are present in the gases that are sampled.*

Bench 200 knows that the Reference signal should be a 5 volt signal. So Bench 200 measures the Reference signal and the difference of that signal from 5 volts. It applies a correction for that difference to each of the gases measured in the composite signal.

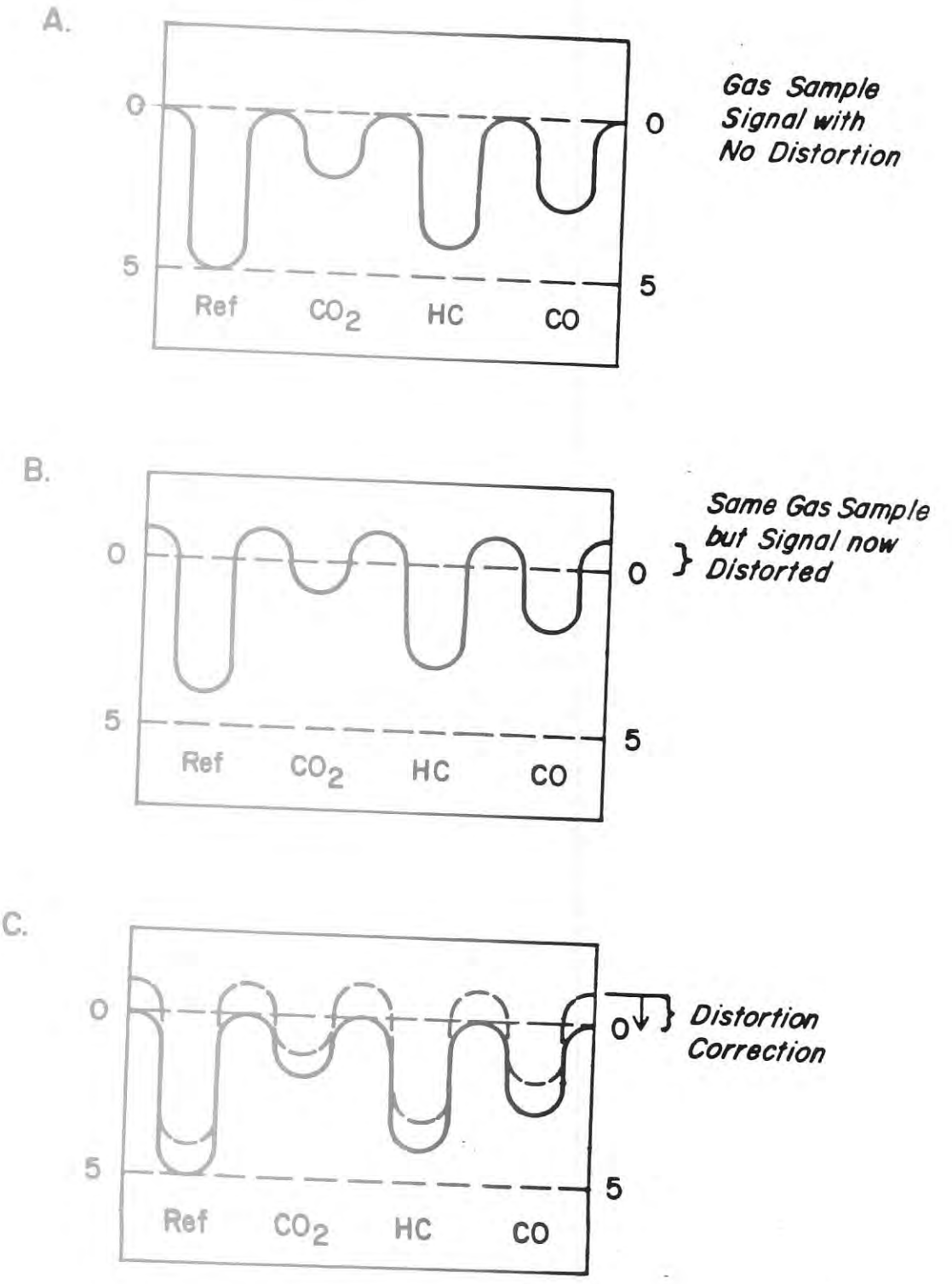
Figure 3-7A, B, C illustrate these points. Figure 3-6A shows a signal in a theoretically perfect system that has no signal distortion.

Figure 3-7B shows a signal in an actual system when distortion has been uncorrected.

Figure 3-7C shows a signal in an actual system after the measurement scale has been corrected.

Note:(*) Nitrogen (N2) is used to establish zero signals for the measured gases and to establish initial conditions for Reference.

Figure 3-7 — Signal Correction (Reference)



6. Synchronizing Signals and Output Signals

1. Synchronizing Signals

Bench 200 NDIR design uses one Reference Filter and a single energy path. This design provides an effective and economical system.

However, the Bench 200 design must also use a synchronizer to count the Dark Level time period and the other signals. By means of a synchronizing circuit, Bench 200 is able to identify which signals are being measured and to control the system.

2. Signal Types Compared

We have now described the two types of Bench 200 signals:

1. The composite signals by which gases of interest are measured for output to the parent system

2. The counting signals by which Bench 200 controls the system and by which it knows what gases are being measured

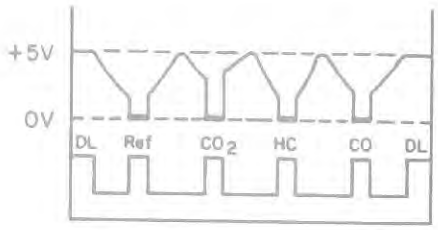
Figure 3-8 illustrates the two types of signals under each of two conditions: with and without gas present.

Each drawing shows an oscilloscope display of two composite signals: (1) the upper half shows the signal for the measured gases, and (2) the lower half shows the counting signals for the measured gases plus those for the Reference signal and for Dark Level.

Figure 3-8 left pictorial shows signals with a sample with no gases present in the sample.

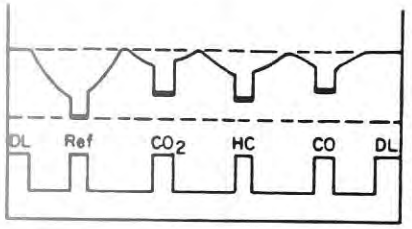
Figure 3-8 right pictorial shows signals with a sample with gases present in the amounts listed.

Figure 3-8 -- Composite Signal (Synchronizing Signal Comparison)



Amount of Gas / Volt

	Gas	Volt
Ref.	Zero	0
CO_2	Zero	0
HC	Zero	0
CO	Zero	0



+5 V TP 3 — *Measurement Signal*

0V From Auto Synchronizer — *Counting Signal*

Amount of Gas / Volt

	Gas	Volt
Ref.	Zero	0
CO_2	5%	4
HC	.805pp	4.5
CO	1.7%	3.98

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4-23 (SAMPLE LENS WIDER)

7. Temperature Controls

Temperature changes cause fluctuations in the amount of infrared and electrical signals produced. Bench 200 provides temperature stability and measurement reliability by maintaining constant temperture in areas where infrared is --

- o generated
- o filtered
- o detected
- o converted to electrical energy

Bench 200 has a heating or cooling circuit wherever such temperature controls are needed. It thus maintains constant temperatures and subsequently ensures reliability of measurement.

Chapter 4 (Operating Basics) identifies these control points for each assembly.

8. Connector

Bench 200 has a connector that provides for --

- o signal output to the parent system
- o testing and calibration from the parent system

9. Adjustments

Bench 200 infrared and electrical control are designed and manufactured to exacting tolerances. Nevertheless, Bench 200 has built-in and easy-to-use controls that provide for adjusting the following system factors:

- o source voltage
- o preamplifier
- o motor speed
- o signal scale for its zero point and full span
- o electronic calibration

10. End of Chapter Notes

Note about Hydrocarbons

This manual discusses HC as if it were a gas just like CO2 or CO. But, because hyrocarbons are different from CO2 and CO gases, Bench 200 actually measures hydrocarbons expressed as Hexane equivalent.

Rather than one substance, hydrocarbons are a group of many substances that exist as suspended particles in the atmosphere. Hydrocarbons number about 26 substances that exist in predictable proportions.*

For that reason, if the quantity of one of the hydrocarbons is known, then the quantity of all of the hydrocarbons is also known. By expressing its measurement in terms of Hexane, Bench 200 in effect indicates the measurement of all hydrocarbons.*

Note: (*) Appendix E (Title 2) lists hydrocarbons.

Chapter 4 -- Operating Basics

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Overview

Bench 200 has two modes:

1. Testing mode

2. Operating mode

This Chapter describes how Bench 200 works in the operating mode, that is, as it works in end-user gas sampling operations.

This Overview is continued on the next page.

Note: diagrams and drawings will accompany the text on the following pages. The illustrations will be labelled with the appropriate paragraph number or with an identifying label number in parentheses (n).

Overview (cont'd)

Bench 200 has five major assemblies. Those assemblies and their functions are as follows:

1. Transformer and Base Plate -

   Transforms line AC power to DC power

2. Power Supply - Provides system DC power

3. Source Assembly -

   Generates infrared radiation (IR) pulses

4. Optical Assembly -

   1. Motor rotates the Filter Wheel

   2. Filters the IR into wavelength bands that will identify CO2, HC, CO, and Reference

   3. Directs the IR through a gas sample in a sample cell

   4. Converts the IR to composite electrical signals

5. Processor PCB -

   1. Synchronizes the system

   2. Corrects distortions in the signals

   3. Measures and separates the signals to identify the type and concentration of gas in the sample

   4. Connects and transmits the signals to the parent system

Power Supply, Source Assembly, and Optical Assembly also have temperature controls (6).

Power Supply, Source Assembly, and Optical Assembly have heat sinks.

Figure 4-1 shows a diagram of those tasks.

Figure 4-2 shows exploded views of the Bench 200 and its major assemblies.

Each assembly is described in detail in the following sections.

Figure 4-1 -- Bench 200 Functional Block Diagram

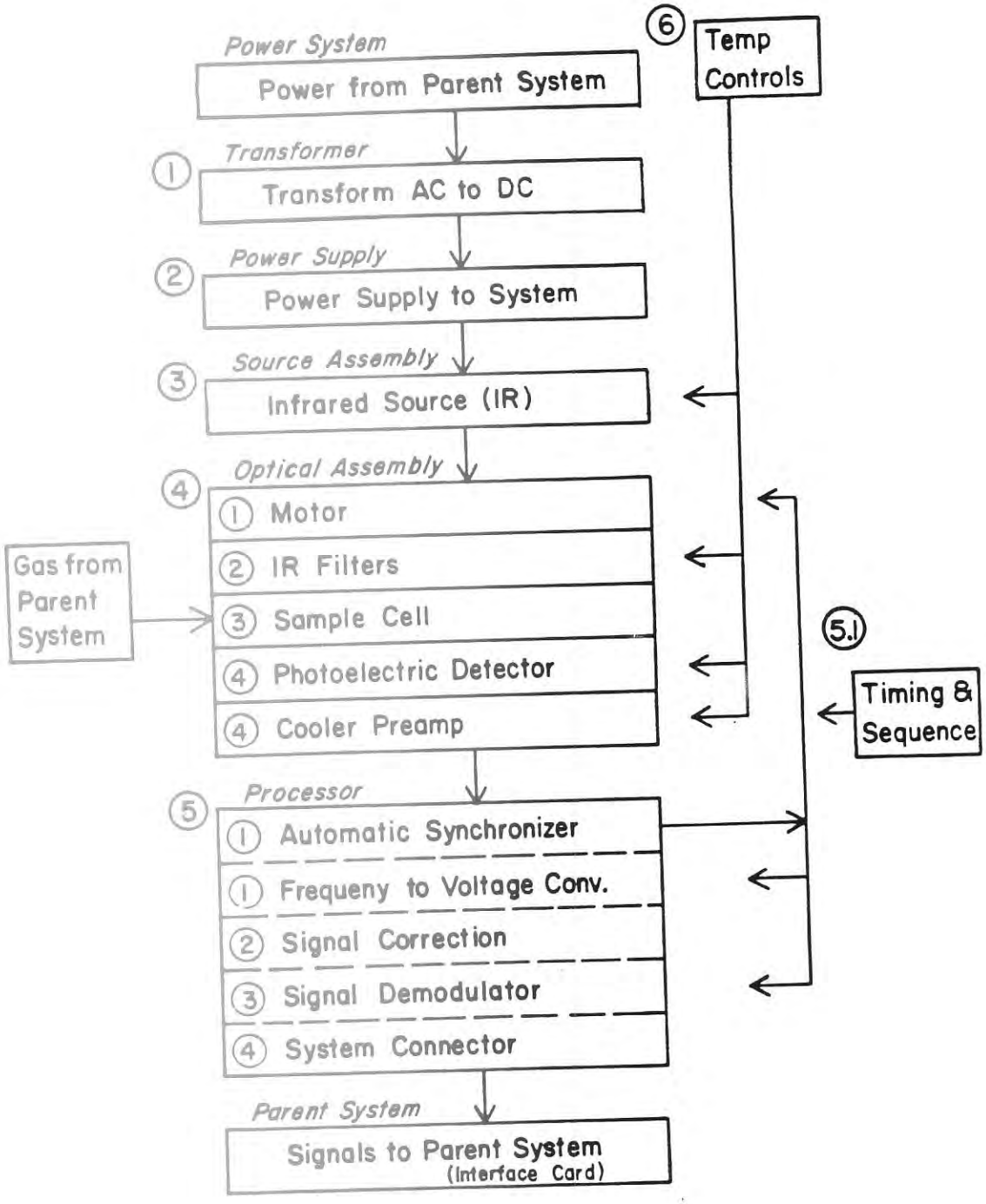

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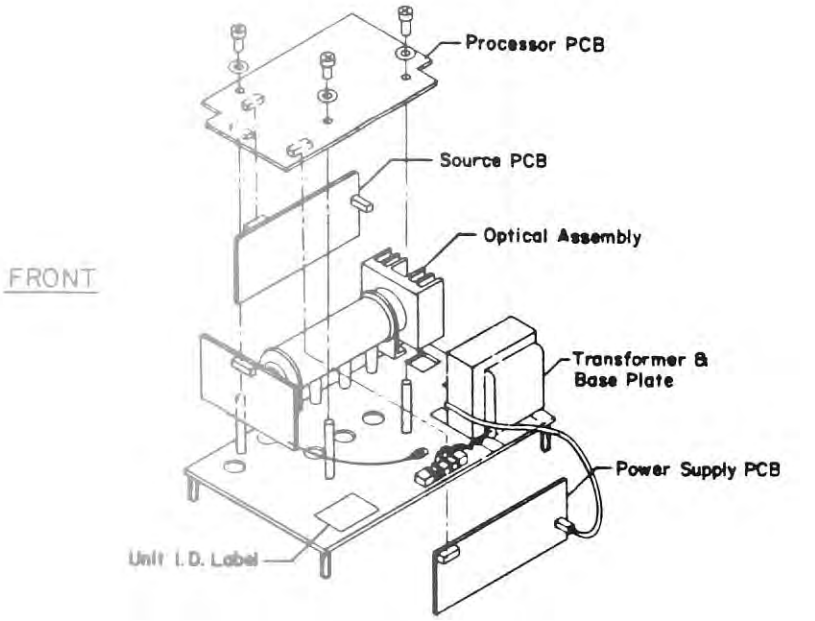
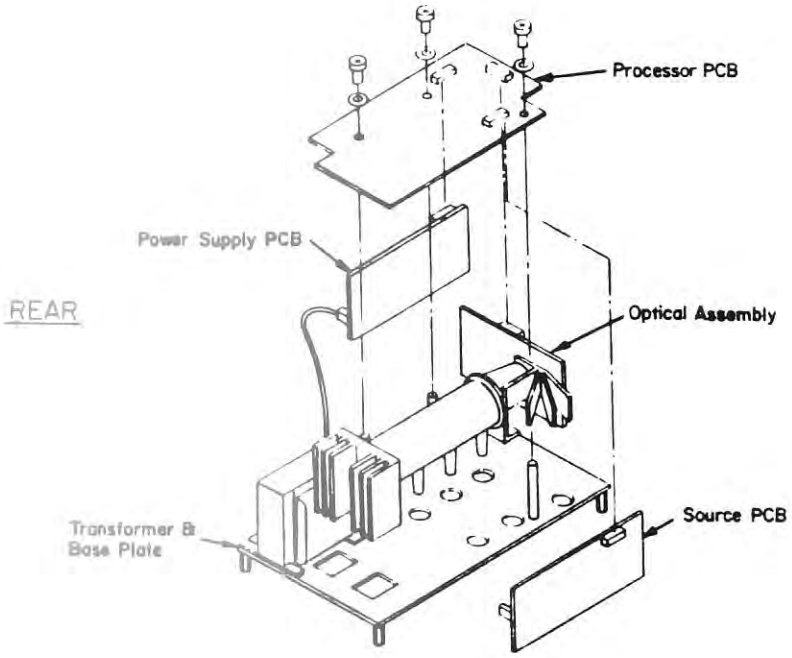
Figure 4-2 -- Bench 200 Exploded Views





1. Transformer and Base Plate

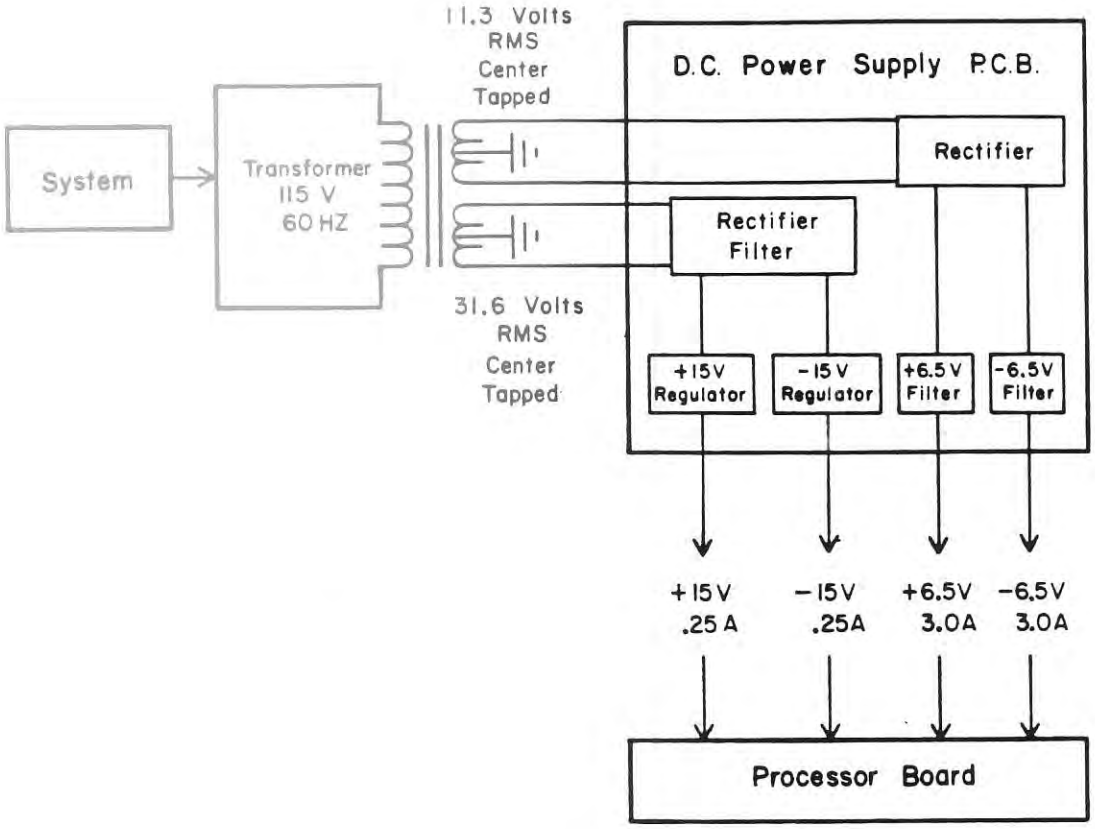
The Base Plate provides a platform for the Transformer and the other four assemblies.

Different wiring for the Transformers determine whether they should be used on 115 VAC or 230 VAC power. The Transformer changes the AC line power from the parent system into DC power for the Power Supply.

Figure 4-3 is a diagram of the Transformer and its connection to the Power Supply.

A Power Supply circuit schematic is in Appendix E.

Figure 4-3 — Transformer and Power Supply Block Diagram



2. Power Supply PCB Assembly

Power Supply PCB regulates its output to regulated +/- 15 volts and filtered (unregulated) +/- 6.5 volts.

Power Supply output first goes to the Processor Assembly (1). Power then goes from the Processor PCB to the --

- Cooler-Preamp PCB (2)
- Source PCB (3)

From the Source PCB power then goes to the Optical Assembly (Filter Wheel Strip Heater, Filter Wheel Motor, and the Filter Wheel Thermistor). (4)

The +/-15V power is for voltage references and operational amplifier power.

The +/-6.5V power is for the Source, Filter Wheel Heater, the Detector Cooler, and the Motor.

Figure 4-4 diagram of the power distribution.

Figure 4-5 is an assembly drawing of the Power Supply PCB.

Figure 4-4 — Power Distribution Block Diagram

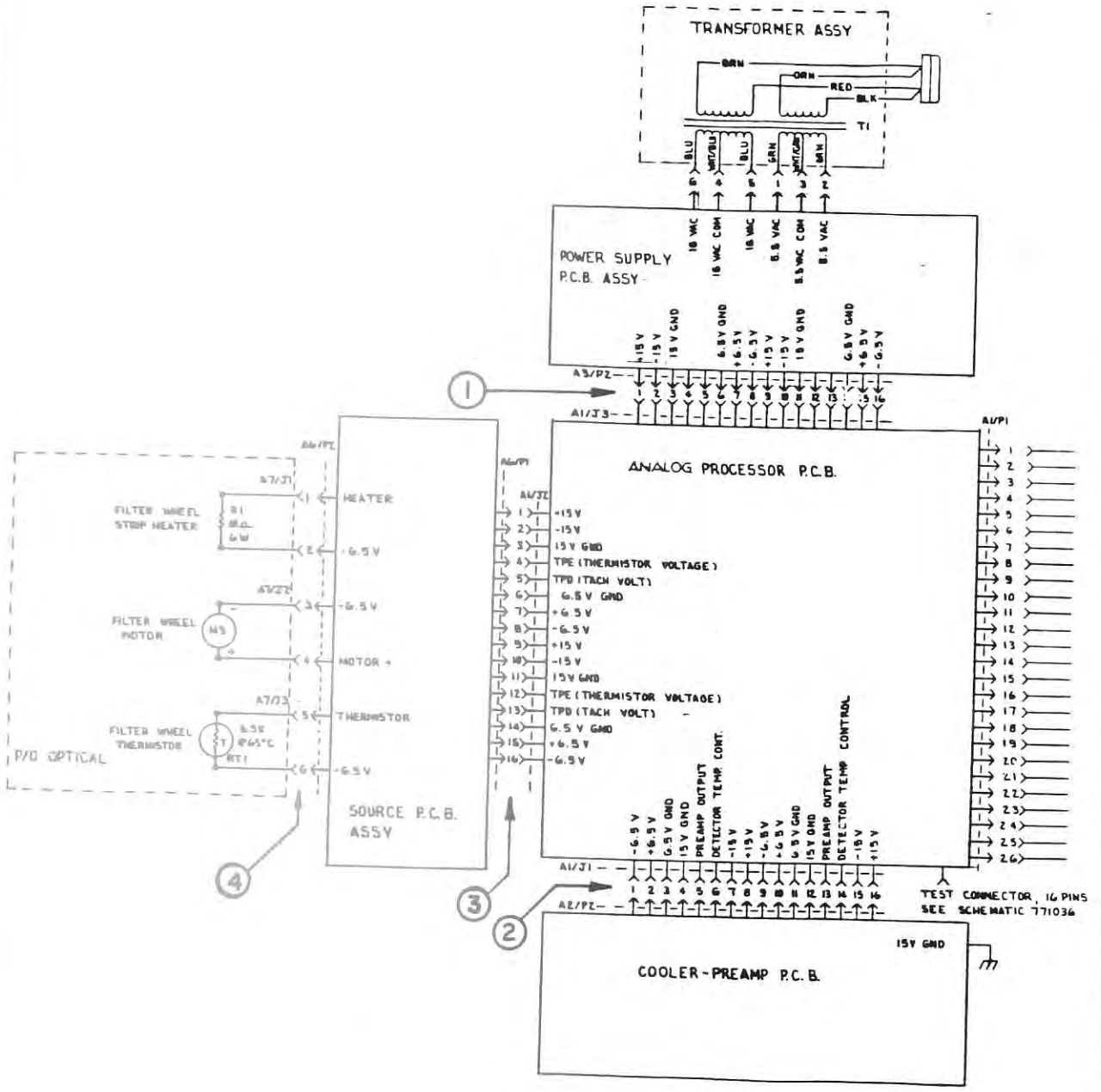


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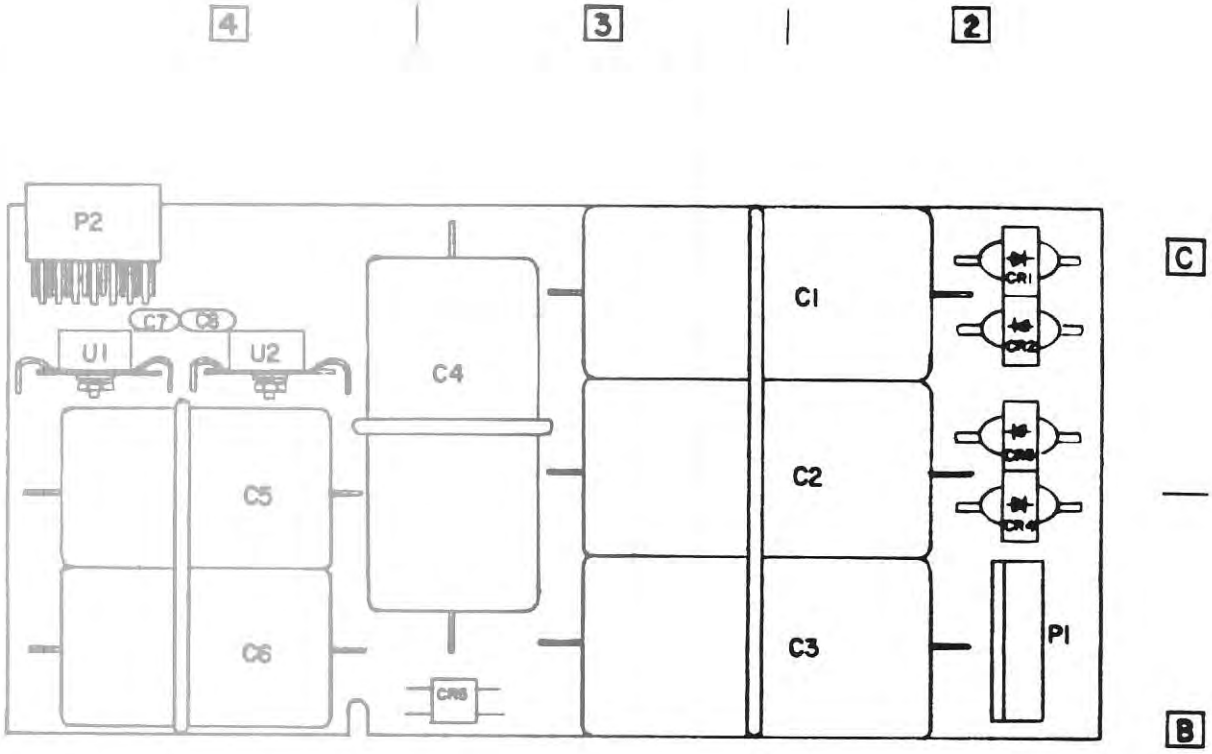
Figure 4-5 -- Power Supply Assembly Drawing



3. Source PCB Assembly

The Source takes power from the Power Supply PCB by way of the Processor PCB. It first applies power to the Source Element via the Source Voltage Regulator. The Source Element directs IR through the Optical Assembly Filter Wheel.

In addition, the Source PCB also provides motor and temperature controls for the Optical Assembly.

The Source Assembly has four major components:

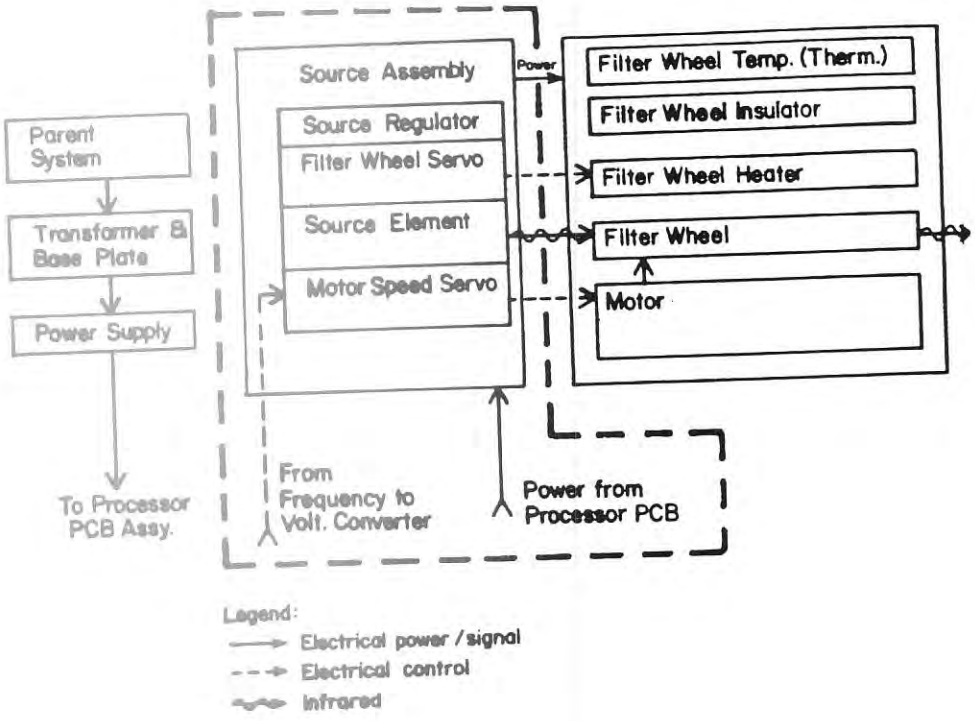
1. Source Voltage Regulator
2. Source Element
3. Motor Speed Servo
4. Filter Wheel Temperature Servo

These subassemblies are described in the following section topics.

Figure 4-6 is a diagram that includes the Source PCB Assembly.

A Source PCB circuit schematic is in Appendix E.

Figure 4-6 — Source Assembly (Highlighted)



3. Source PCB Assembly (Cont'd)

1. Source Voltage Regulator

The Source Voltage Regulator receives power from the Power Supply PCB by way of the Processor PCB.

The Source Voltage Regulator then applies 7.8V to the Source Element. One side of the Source Element, the drive side, receives this +7.8V input. The other side of the Source Element is connected to -6.5V power.

This circuit then causes the Source Element to generate the desired beam of IR pulses to the Optical Assembly.

2. Source Element

The Source Element is ceramic-sealed tungsten emitter. The Source is heated to 800 degrees centigrade by the Source Voltage Regulator. It then generates IR energy in pulses with wavelengths that cover the range of 2.5 micrometers to 6.0 micrometers. Bench 200 directs this band of energy at the filter wheel.

The Source Element is positioned to touch the Motor Heat Sink so that Source heat will dissipate.

3. Motor Speed Servo

5700 RPMs

The Motor Servo maintains the Optical Assembly Filter Wheel Motor at 5700 RPM. The Motor Speed Servo in turn is synchronized by the Processor PCB.

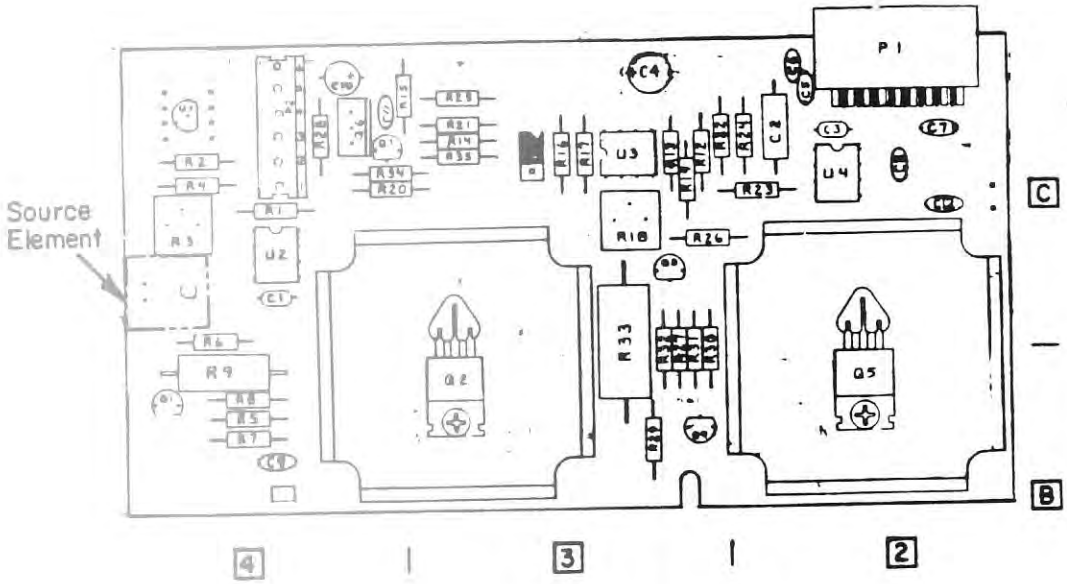
4. Filter Wheel Temperature Servo

The Filter Wheel Temperature Servo maintains the Filter Wheel at a constant 65 degrees centigrade. This minimizes IR fluctuations.

The Filter Wheel Temperature Servo receives its control information from a thermistor that is mounted on the Filter Wheel Housing in the Optical Assembly Sample Cell.

Figure 4-7 is an assembly drawing of the Source PCB Assembly.

Figure 4-7 — Source PCB Assembly Drawing



4. Optical Assembly

The Optical Assembly takes power and IR energy pulses from the Source PCB assembly. The Optical Assembly filters the IR and converts it to composite electrical signals. The Optical Assembly then sends the composite signals to the Processor PCB Assembly.

The Optical Assembly has five major components:

1. Motor Subassembly
2. Filter Wheel Subassembly
3. Sample Cell
4. Detector
5. Cooler-Preamp PCB

Figure 4-8 is a diagram showing the relationships of these assemblies.

Figure 4-9 is an assembly drawing of an exploded view of these subassemblies.

Each subassembly is described in the following section topics.

Note: Temperature controls include the Filter Wheel Heater, Filter Wheel Thermistor, and Detector Thermistor.

Figure 4-8 -- Optical Assembly Block Diagram

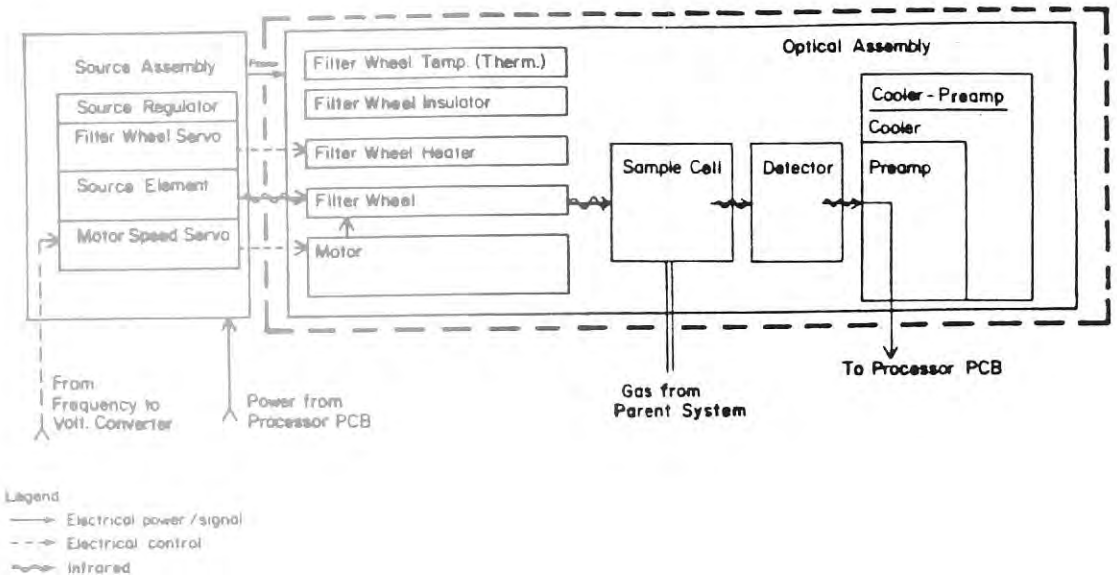


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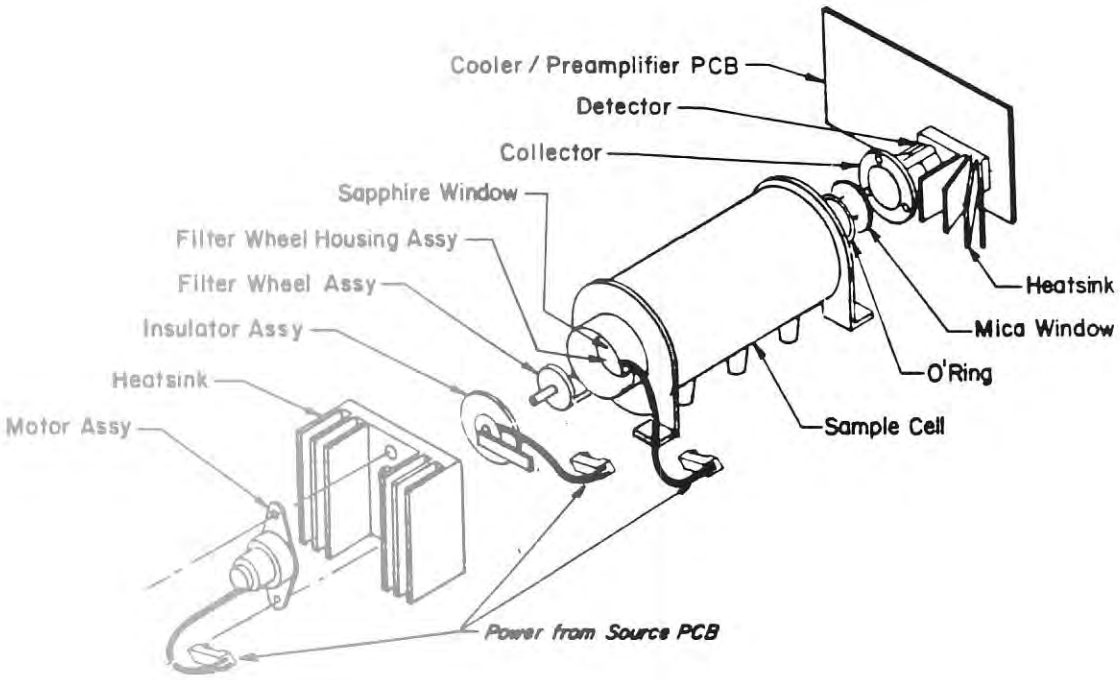
Figure 4-9 -- Optical Assembly Exploded View



4. Optical Assembly (cont'd)

1. Motor Subassembly

The Motor Subassembly drives the Filter Wheel at a constant 5700 RPM (95 Hz +/- 2 Hz). It receives RPM control from the Motor Speed Servo (Source Assembly).

The Motor is insulated from the Heatsink and dissipated Source heat.

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2. Filter Wheel Subassembly

The Filter Wheel is divided into five sectors, one for:

1. Reference Filter,
2. CO2 Filter
3. HC Filter
4. CO Filter
5. Dark Level (blank)

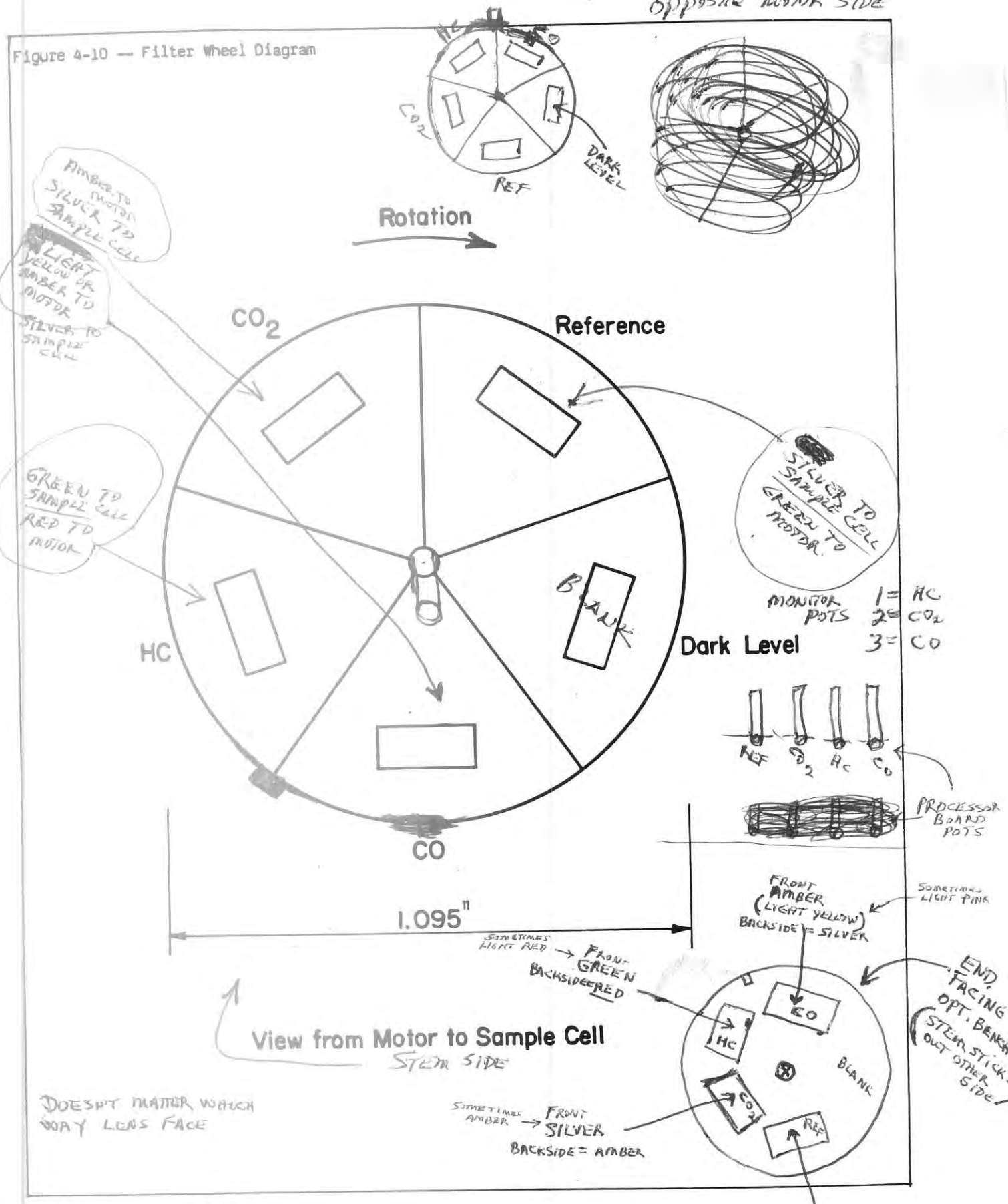
The Filter Wheel rotation creates four time slots, one for each of those four filters. A fifth time slot is generated by a synchronizing circuit in the Processor.

The Filter Wheel lets only selected IR pulses pass through it to the Sample Cell. It also puts these pulses going to the Sample Cell in a specific order.

Figure 4-10 is a drawing showing the location of the filters on the Filter Wheel.

The Filter Wheel Assembly includes an insulator to protect the Motor from Filter Wheel heat. Filter Wheel temperature is also controlled by the Strip Heater mounted on the Filter Wheel Housing on the Sample Cell. A Filter Wheel Thermistor senses the temperature of the Filter Wheel Housing.

Figure 4-10 -- Filter Wheel Diagram



4. Optical Assembly (cont'd)

3. Sample Cell

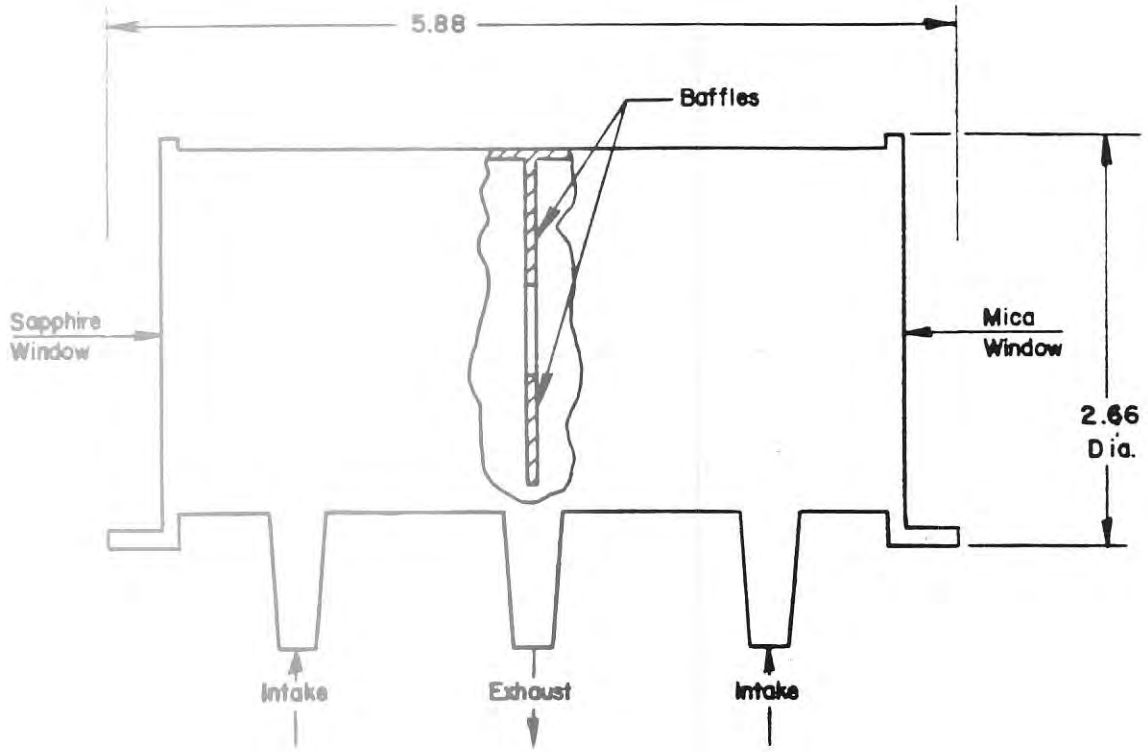
The Sample Cell takes in and expels the sample gases from two intakes and one exhaust port on the bottom of the cell. A patented design includes baffles and a water drain that helps keep the IR windows clean. The Sample Cell provides for smooth, rapid gas flow with complete mixing.

The IR pulses enter the Sample Cell through a 0.375 inch diameter, sapphire window. As the pulses pass through the cell, the gases absorb some of the IR in their IR energy bands. The then modified IR pulses pass from the Sample Cell through a 1.88 inch diameter, mica window to the Collector and the Dectector.

The Sample Cell provides the housing for the Filter Wheel Assembly and the Strip Heater.

Figure 4-11 is a drawing of a side view of the Sample Cell.

Figure 4-11 -- Sample Cell Drawing



4. Optical Assembly (cont'd)

4. Detector

The Detector receives the IR energy after it has come from the Sample Cell and it has been concentrated on the Detector surface by the Collector.

The Detector, made of photoelectric lead selenide, converts the IR energy into electrical signals. The Detector then sends its composite signal to the Cooler-Preamp.

The Detector is cooled by a thermoelectric cooler.

5. Cooler-Preamp

1. Cooler

The Cooler circuit in the Cooler-Preamp PCB Subassembly operates in the following way:

- o A thermistor senses the Detector temperature.
- o The circuit compares the Detector temperature against the desired temperature of zero degrees Fahrenheit.
- o Depending on the comparison above or below the desired temperature, the ciruit sends current to either the thermoelectric cooling or heating side of the circuit. Hot junction is mounted to a Detector leader which mounts to the Heat-sink.

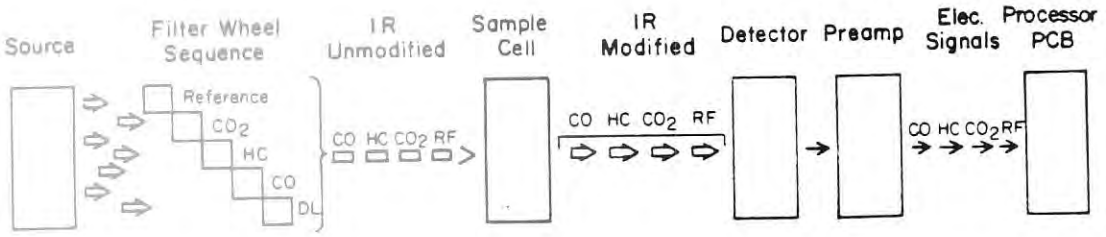
2. Preamp

The Preamp amplifies signals from the Detector. It then sends these amplified signals to the Processor PCB Assembly.

Figure 4-12 is a drawing that shows conversion of IR energy from the Source Element to electrical signals sent from the Cooler-Preamp.

Figure 4-13 is an assembly drawing of the Cooler-Preamp PCB.

Figure 4-12 -- Conversion of Infrared Energy to Electrical Signals



Legend:

IR Energy ⇨⇨

Electrical Signals →→

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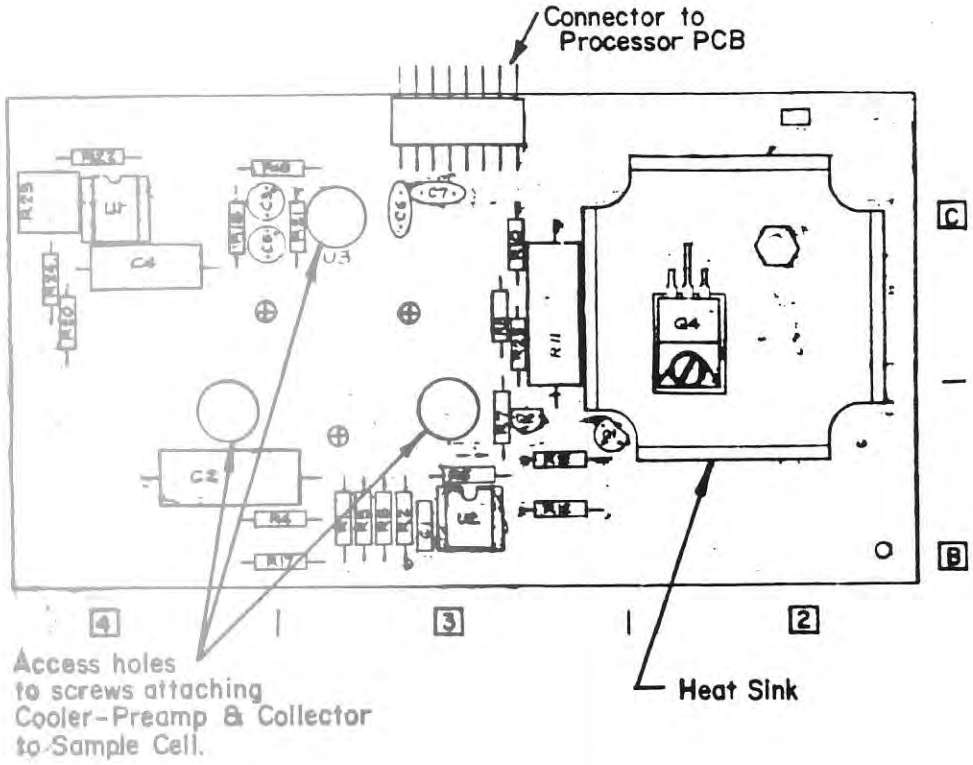
Figure 4-13 -- Cooler-Preamp PCB Assembly Drawing



5. Processor PCB Assembly

The Processor PCB Assembly does five major tasks. The five tasks are as follows:

1. Generates a tach signal to drive the Motor at a constant speed
2. Synchronizes circuitry that measures the gas signals
3. Corrects distortions to the signals for CO2, HC, and CO
4. Separates the composite signal into three separate output signals
5. Provides an interface connector by which it sends those signal outputs to the parent system.

Those tasks are done by the following circuits:

1. Automatic Synchronizer
2. Frequency To Voltage Converter
3. Signal Demodulator Circuits
    1. Dark Level Command Signal
    2. Automatic Gain Control
    3. Selective Gain Amplifier
        1. Timing of Signal Measurement
        2. Signal Error Gain Control
    4. Dark Level Circuit
    5. Demodulator
4. Interface Connector

Figure 4-14 is a diagram showing the relationships of those components.

Figure 4-15 is an assembly drawing of the Processor PCB.

Figure 4-14 — Processor PCB Block Diagram

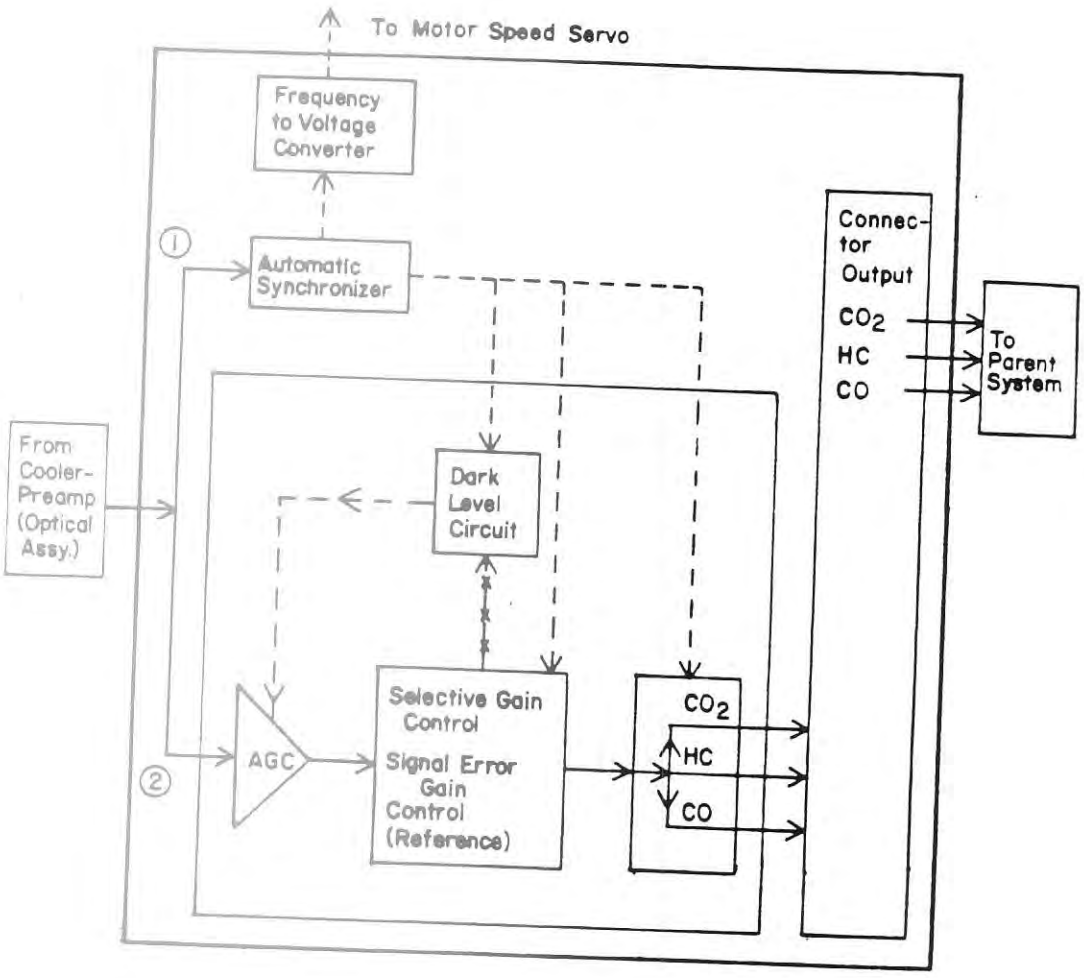


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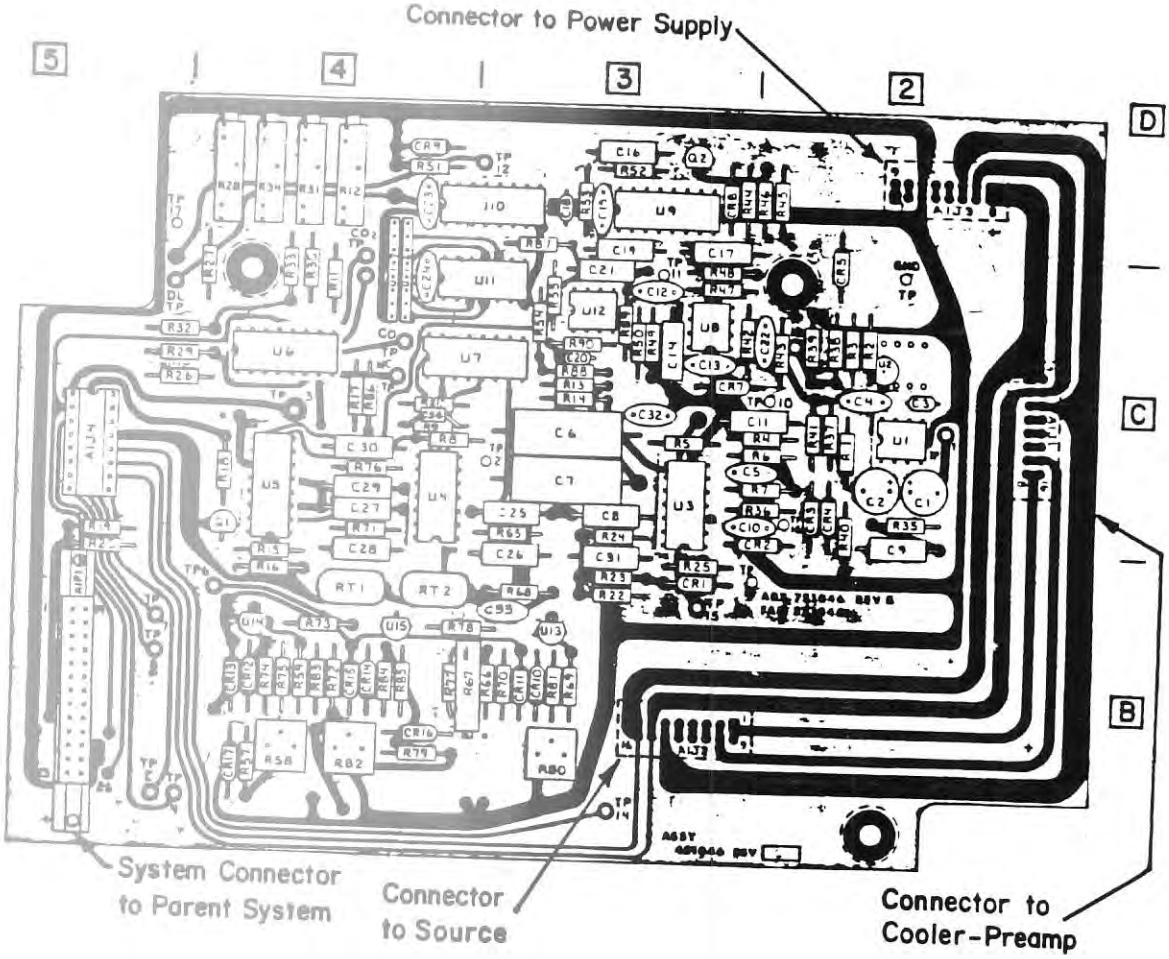
Figure 4-15 — Processor PCB Assembly Drawing



5. Processor PCB Assembly (cont'd)

Upon entering the Processor PCB, the signal follows two circuits. One is to the Automatic Gain Control in the Signal Demodulator Circuits.The other is s to the Automatic Synchronizer.

Figure 4-16 is a diagram showing the circuits concerned with the Automatic Synchronizer and the Frequency to Voltage Converter.

1. Automatic Synchronizer

The Automatic Synchonizer receives the composite signal from the Preamp signal (1).

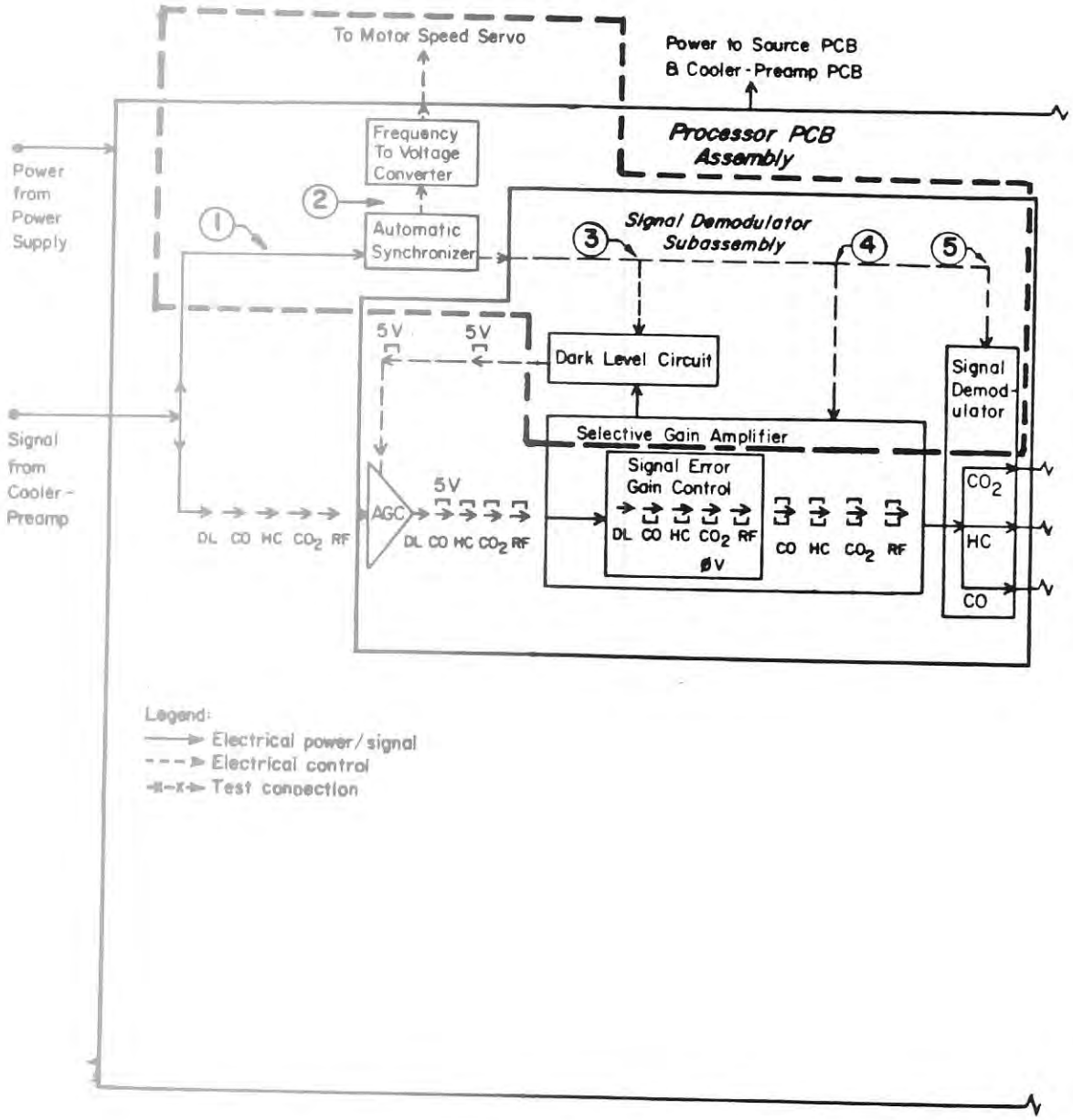
One of its tasks is to note the absence of a signal (Dark Level) and to determine the signal rate. It then sends this rate information to the Frequency To Voltage Converter (2).

The Automatic Synchronizer also sends signal rate information for Reference, CO2, HC, and CO to the the Dark Level Circuit (3), the Selective Gain Amplifier (4), and the Demodulator (5).

2. Frequency To Voltage Converter

The Frequency To Voltage Converter takes the signal rate information from the Automatic Synchronizer and first smooths that signal. It then generates a tach signal to drive the Motor Servo. The Motor Servo then controls the speed of the Motor.

Figure 4-16 — Automatic Synchronizer Circuit Diagram



5. Processor PCB Assembly (cont'd)

3. Signal Demodulator Circuits

1. Dark Level Circuit Command Signal

The Dark Level Circuit sends a command signal to the Automatic Gain Control. This command signal adjusts the AGC measurement to a 5 volt maximum reading (The Dark Level Circuit is described in more detail below).

This circuit measures the Dark Level signal and sends it to the Automatic Gain Amplifier. The Automatic Gain Applifier applies that signal as a correction to the measurement of CO2, HC, and CO.

2. Automatic Gain Control (AGC)

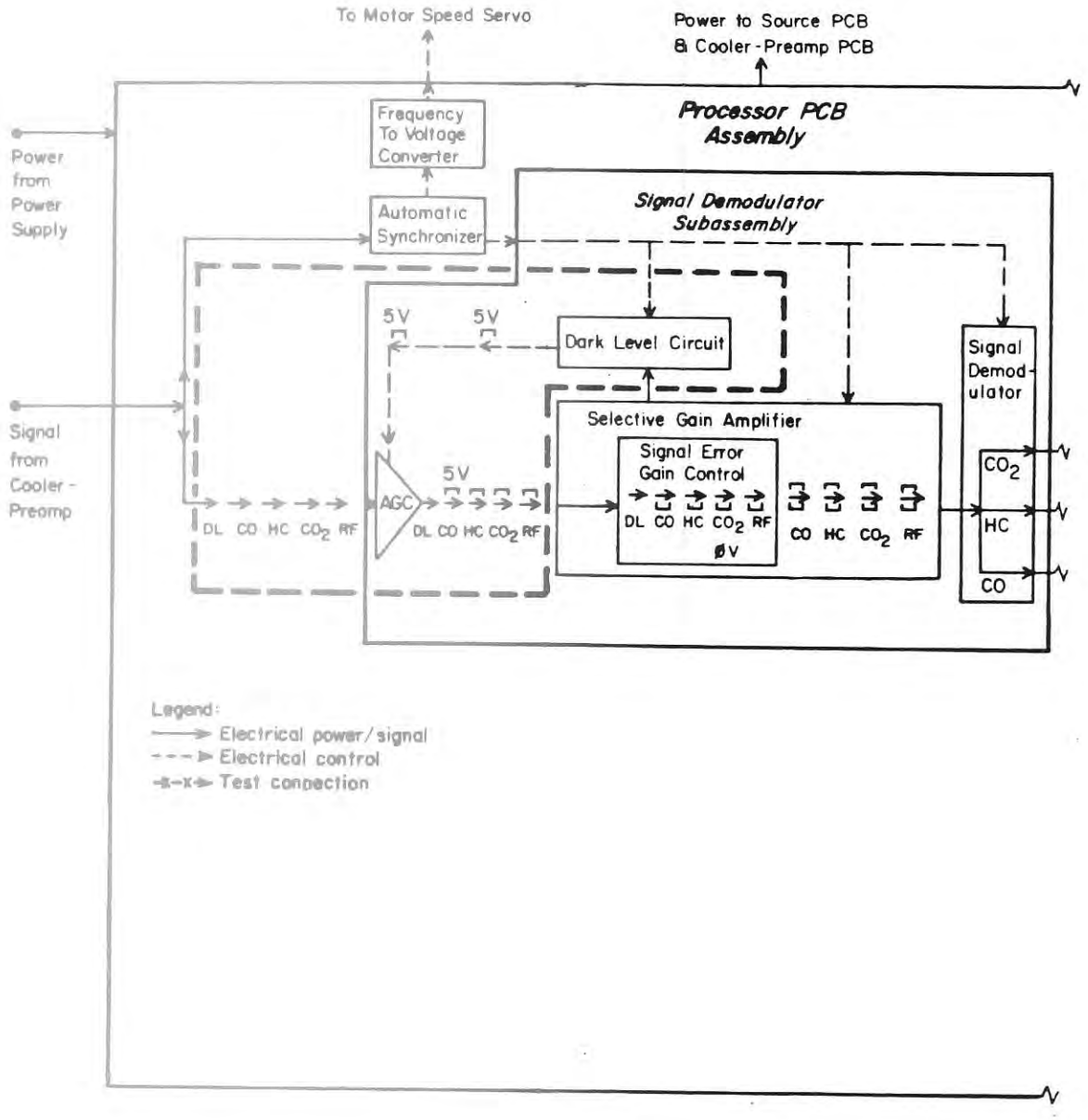
The Automatic Gain Control (AGC) receives composite signals from the Preamp.

The AGC also receives a command signal from the Dark Level Circuit. This Dark Level signal tells the AGC to reset the measurement scale to the 0-5 volt range.

The AGC then sends that adjusted signal to the Selective Gain Amplifier.

Figure 4-17 is a diagram showing that process.

Figure 4-17 -- Automatic Gain Control/Dark Level Circuit Diagram



5. Processor PCB Assembly (cont'd)

3. Signal Demodulator Circuits (cont'd)

3. Selective Gain Amplifier

The Selective Gain Amplifier also receives signals from two components: (1) timing signals from the Automatic Synchronizer and (2) a signal from the Automatic Gain Control that has been modified by the Dark Level command signal.

1. Timing of Signal Measurement

With the timing signals from the Automatic Synchronizer, the Selective Gain Amplifier knows exactly when to measure signals during the periods for the Reference, CO2, HC, or CO.

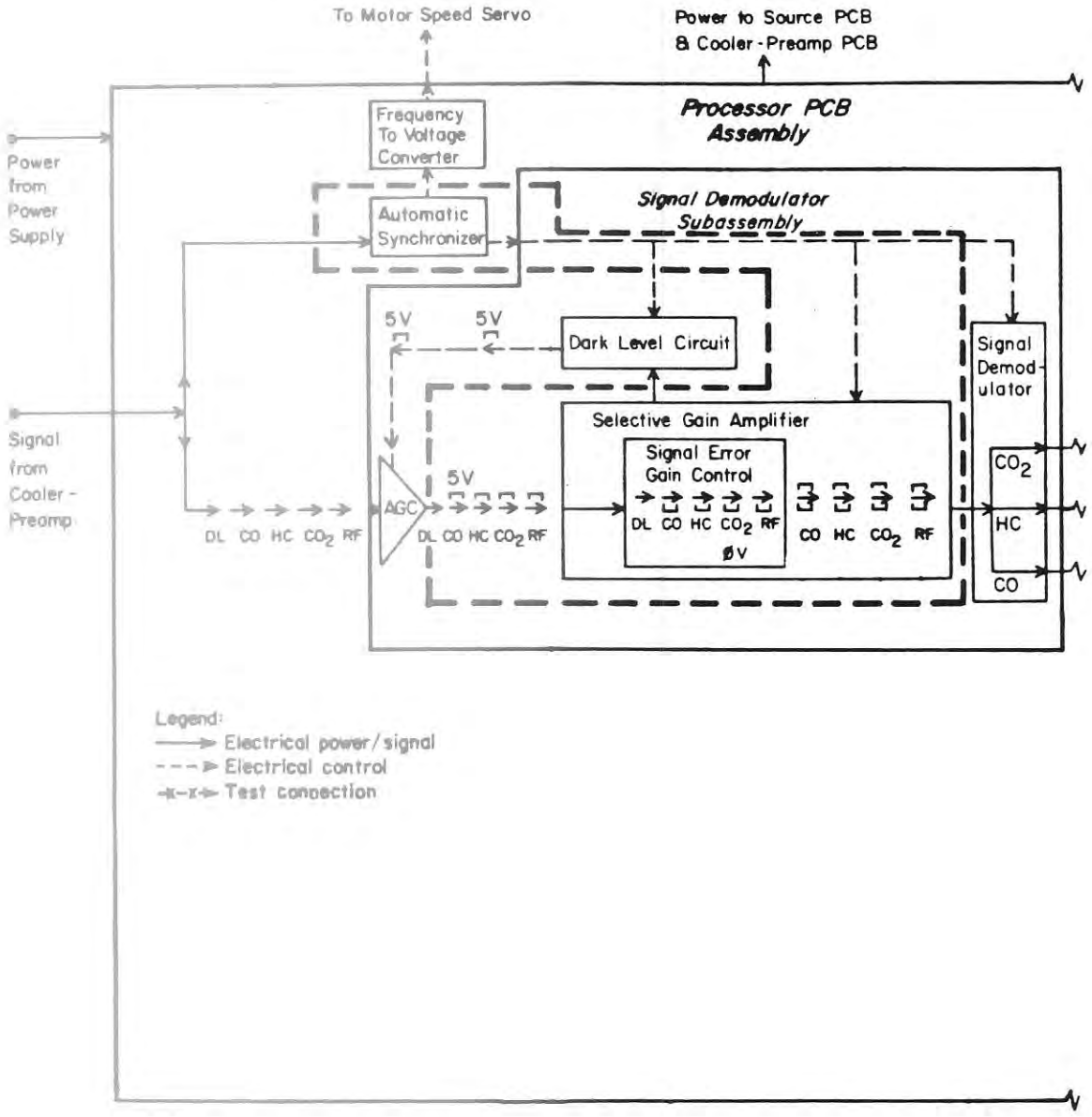
2. Signal Error Gain Control

The Signal Error Gain Control measures the Reference signal against zero on the measurement scale. It then applies that correction to the measurement of the composite CO2, HC, and CO signals.

That last task, together with the Dark Level Circuit Adjustment, completes the Bench 200 corrections for signal distortion.

Figure 4-18 is a diagram that illustrates that process.

Figure 4-18 — Selective Gain Amplifier Circuit Diagram



5. Processor PCB Assembly (cont'd)

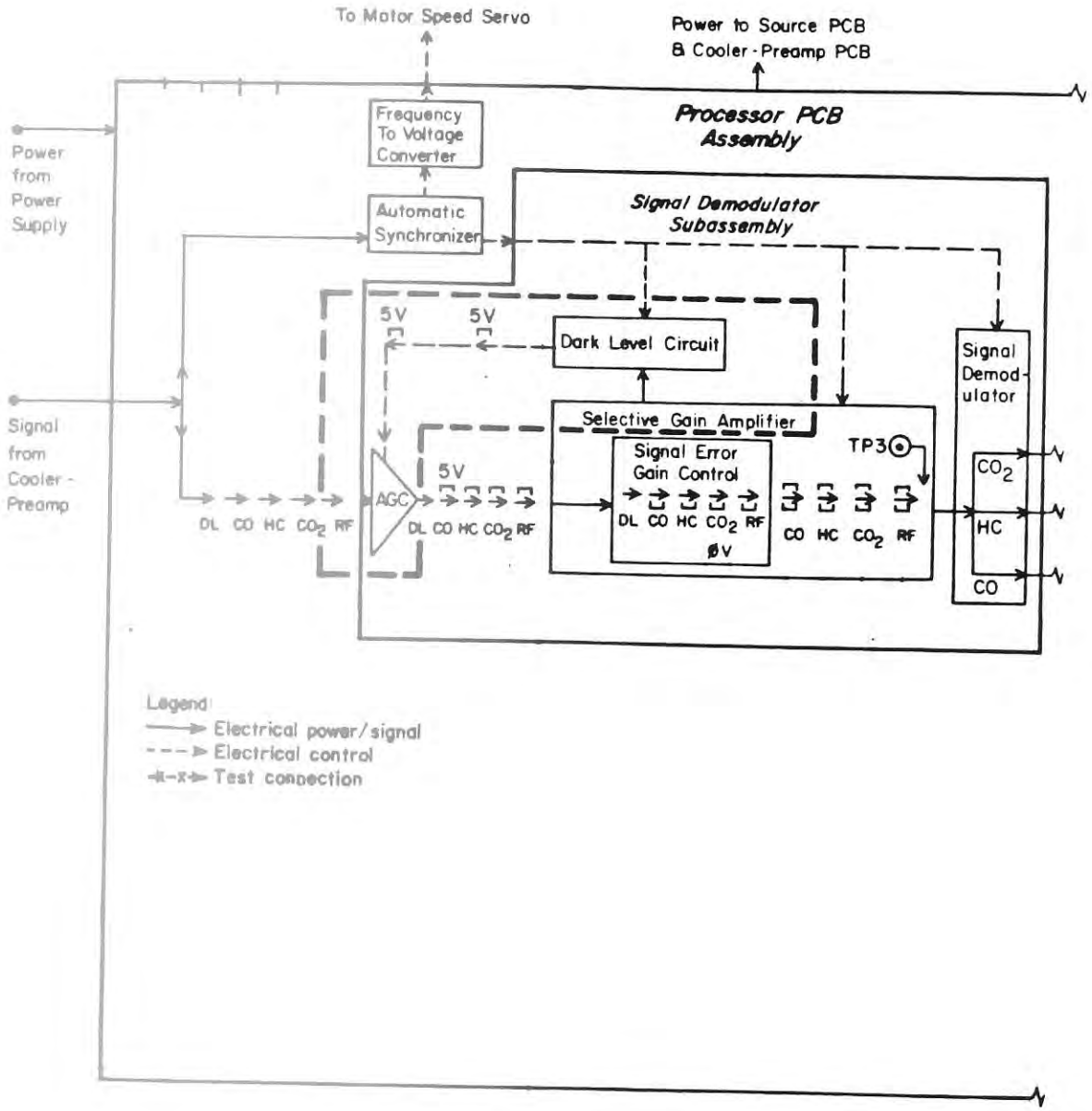
3. Signal Demodulator Circuits (cont'd)

4. Dark Level Circuit

This circuit measures Dark Level signals received from the Selective Gain Amplifier. The Dark Level Circuit compares these signals to 5 volts. It then identifies the amount of the signal above 5 volts as a needed correction. It then sends that correction as a command signal to the Automatic Gain Amplifier. The Automatic Gain Applifier applies that correction to the measurement of CO2, HC, and CO.

Figure 4-19 illustrates that process.

Figure 4-19 -- Dark Level Circuit Diagram



5. Processor PCB Assembly (cont'd)

3. Signal Demodulator Circuits (cont'd)

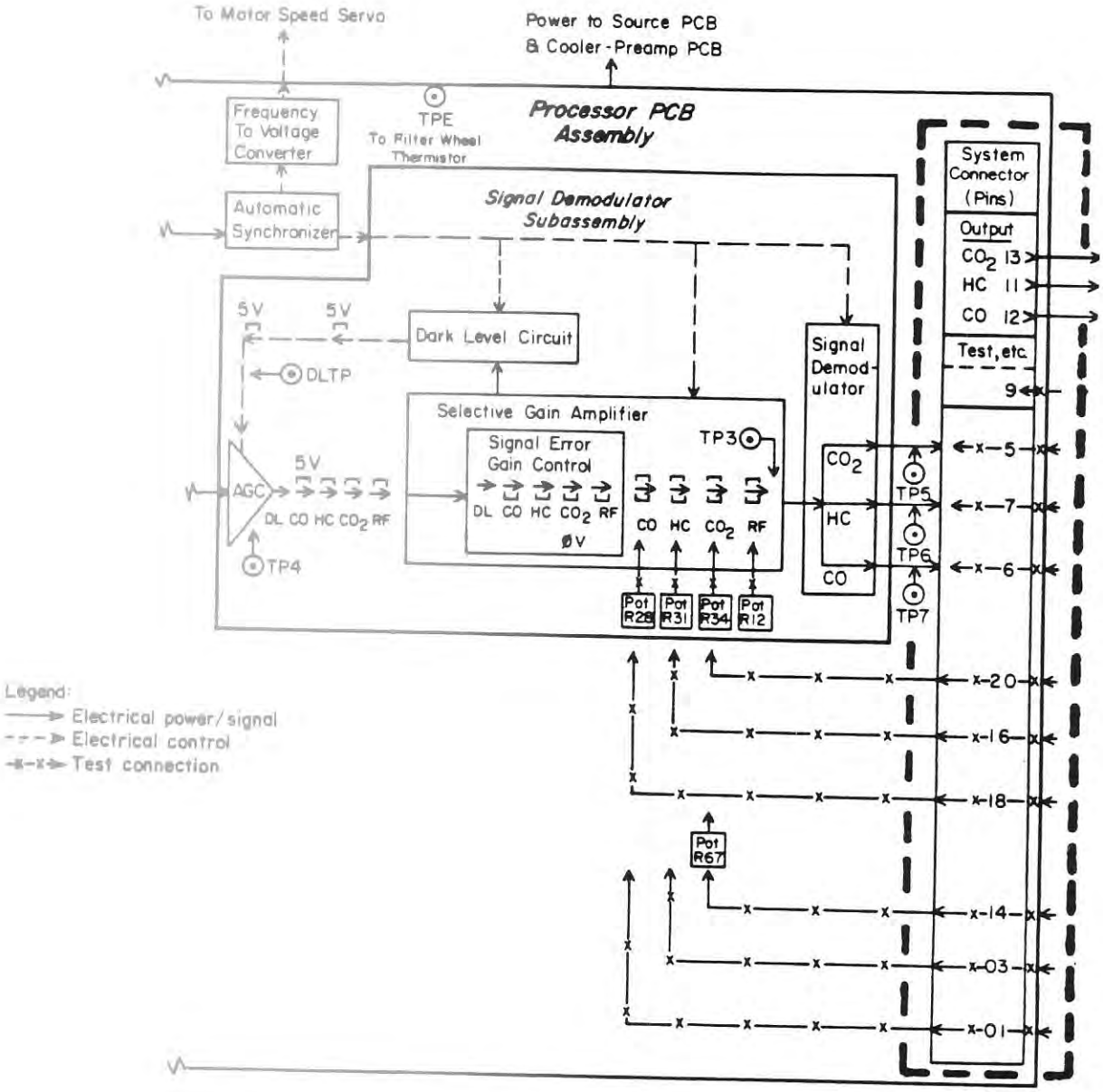
5. Signal Demodulator

The Signal Demodulator separates the composite signal into three signals, one each for CO2, HC, and CO. Then it filters each signal and amplifies it on a 0-5 volt analog scale.

It then sends these signals to the Interface Connector

Figure 4-20 illustrates that process.

Figure 4-20 — Signal Demodulator Circuit Diagram



5. Processor PCB Assembly (cont'd)

4. Interface Connector

The Interface Connector has 26 connecting pins. The Connector pins are categorized as follows:

1. Output Signal - 3 pins
2. Interface Control - 16 pins
3. Ground and Factory Test - 7 pins

Figure 4-21 lists the Connector pins according to those categories.

An Interface Connector circuit schematic is in Appendix E.

Figure 4-21 — Interface Connector Pin Assignments

1. Signal Output -	CO2	13	To Parent System
	HC	11	
	CO	12	
2. Interface Control			
1. Test Signal			
Zero Adjustment for	CO2	05	
	HC	07	
	CO	06	
2. Electrical Calibration			
Adjust for	CO2	20	From Calibration Card
		21	
	HC	16	From Calibration Card
		17	
	CO	18	From Calibration Card
		19	
3. Gas Span Adjustabilty for -			
	CO2	14	From Calibration Card
		15	
	HC	03	From Calibration Card
		04	
	CO	01	From Calibration Card
		02	
4. Testing Command			
Command Calibration		09	
3. Ground and Factory Testing			
Command Ground		08	From Calibration Card
Ground, Signal		10	(for pins 5, 6, 7)
Ground, Signal		24	
Ground, Signal		25	
Test		22	for factory test only
Test		23	+15v, test only
Test		26	-15v, test only

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Figures on the next four pages are as follows:

Figure 22 (Sheets 1 and 2) is an overall diagram of the Transformer, Power Supply, and Optical Assembly.

Figure 23 (Sheets 1 and 2) is an overall diagram of the Processor PCB.

Figure 4-22 — Transformer, Power Supply, and Optical Assembly Block Diagram (Sheet 1)

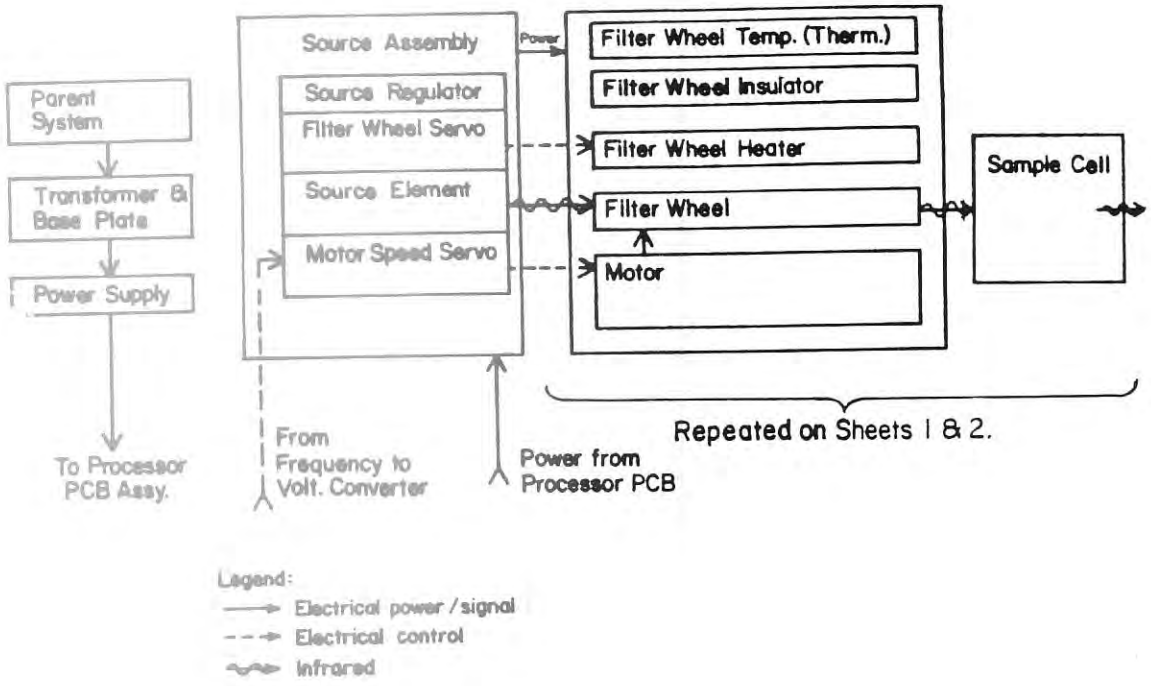


Figure 4-22 -- Transformer, Power Supply, and Optical Assembly Block Diagram (Sheet 2)

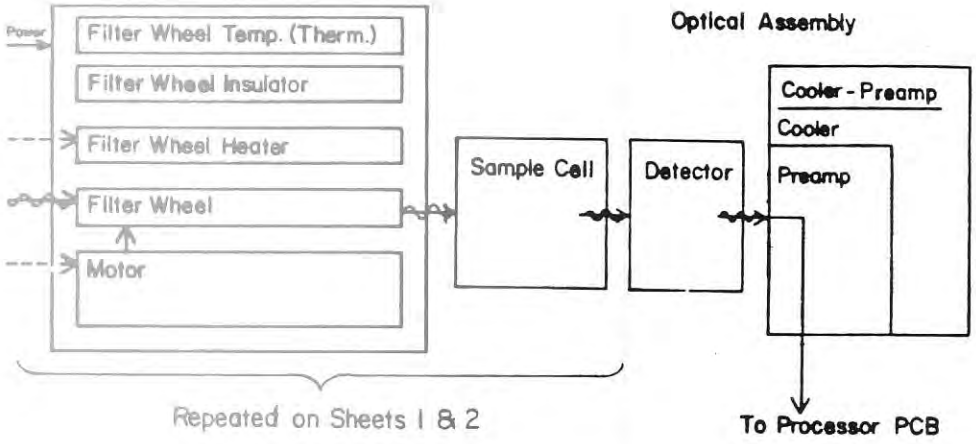


Figure 4-23 — Processor PCB Block Diagram (Sheet 1)

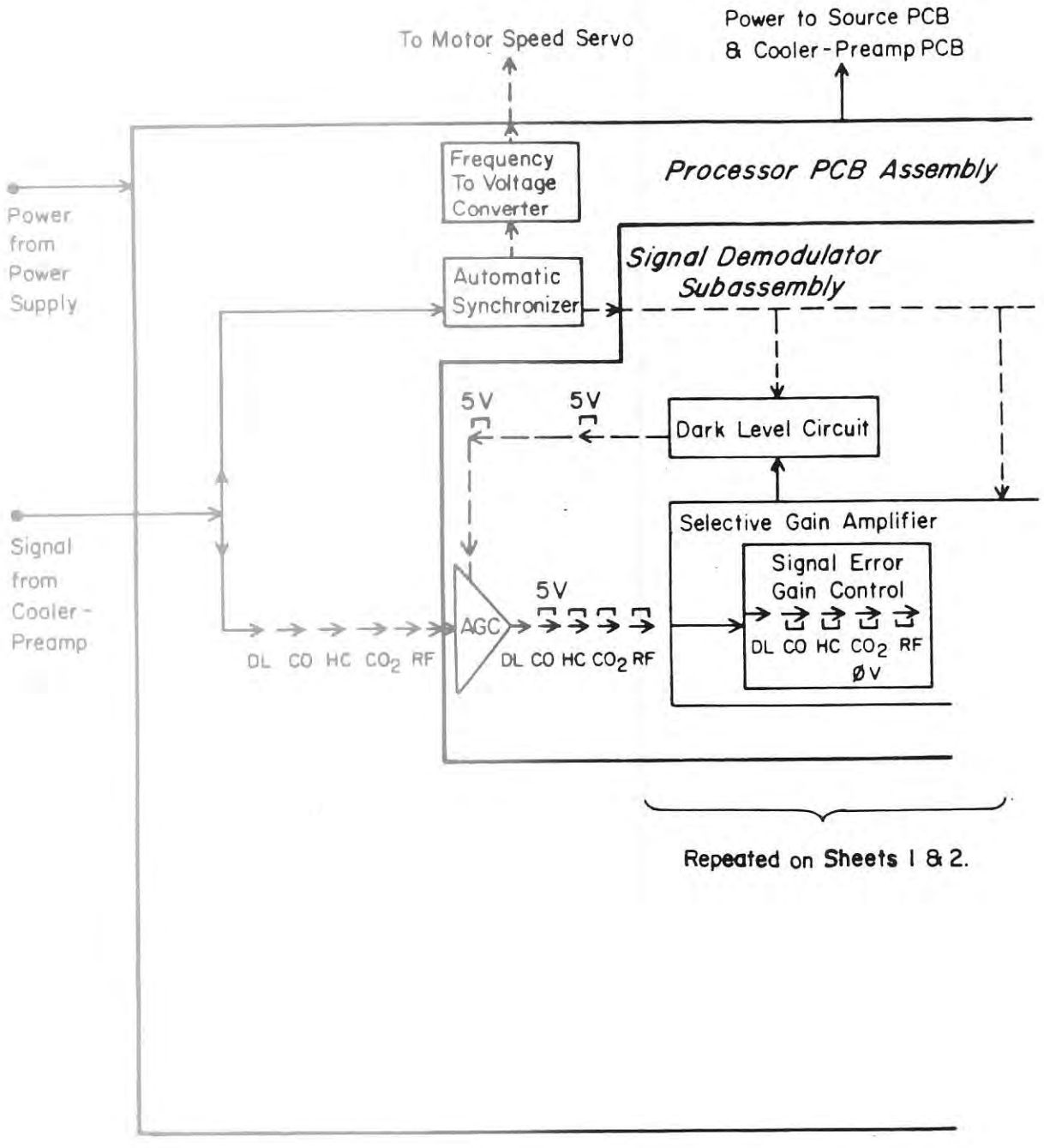
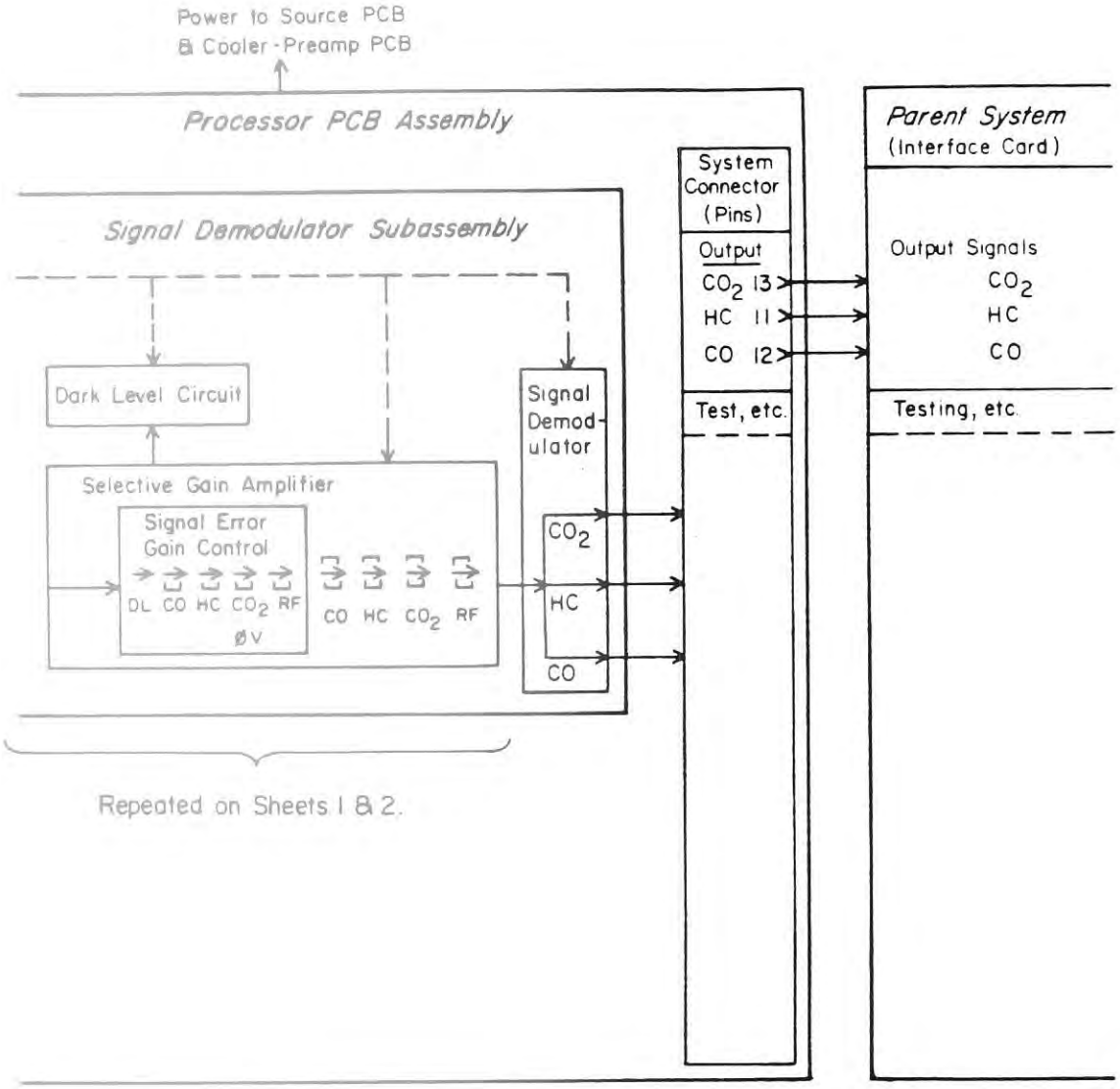


Figure 4-23 — Processor PCB Block Diagram (Sheet 2)



Chapter 5 — Testing Basics

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   5. Processor PCB Assembly 5-10
   6. Interface Card (Optional) 5-10

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   1. Source PCB 5-12
   2. Cooler-Preamp PCB 5-16
   3. Processor PCB 5-20
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Overview

This chapter describes the testing mode of Bench 200, the second of its two modes. Chapter 6 will describe in detail the procedures by which you perform Bench 200 tests for Maintenance Level 1 and Level 2.

Before leaving the factory, every Bench 200 unit is fully tested and calibrated (Chapter 2 -- Product Definition).

However, most operating environments differ from the factory. And, the operating environments themselves are continually changing. Therefore, acceptance testing and periodic testing thereafter may be required.

Because of the importance of field system test, Bench 200 has easy-to-use adjustment controls for each of its critical points. This chapter will broadly discuss the following:

- Test component types
- What the test components do
- Where and how the tests work

1. Types of Bench 200 Testing Components

Bench 200 has several components and circuits just for testing the system. The kinds of components and circuits are as follows:

1. Test Points -

Test Points (TPs) are contact points specifically built into the system for testing particular points in the circuits.

2. Testing Components -

Testing components are specific capacitors, resistors, etc., that are also used as contact points to test particular points in the circuits (no TPs exist for these points).

3. Test Connectors -

Test Connectors consolidate in one place contacts needed for many tests. Test connector contacts are not actually at the circuit location tested. Bench 200 has one specifically-designated test connector. The Interface Connector is also used as a test connector.

4. Pots -

Pots (Potentiometers) are manually adjusted, variable resistors. They are used to set the voltages of components within ranges that are then maintained by electronic control.

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2. Interface Card

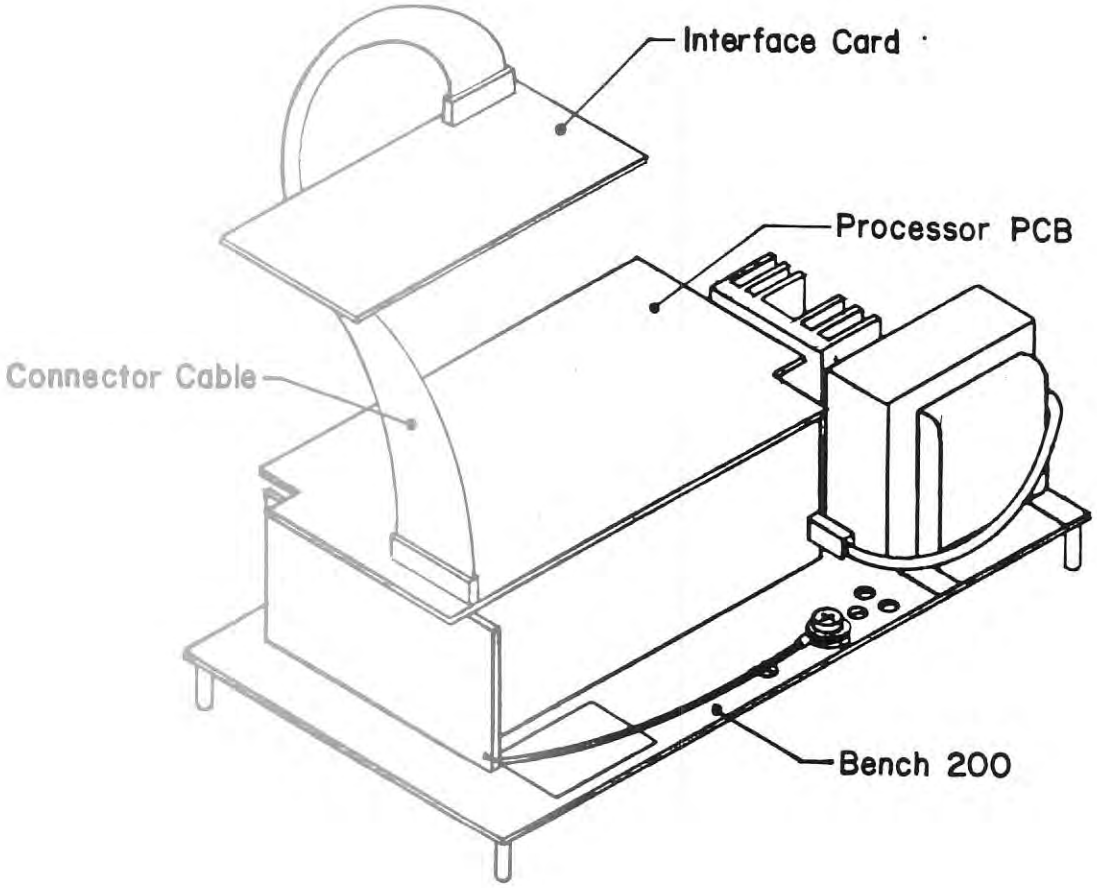
When in the test mode, Bench 200 uses an interface card which we call the Interface Card. OEMs commonly have interface cards of their own design. For purposes of this manual, we will describe the use of the Andros Interface Card (formerly called the RADIM, Remode Adjustment Digital Interface Module).

Interface Card testing serves the following two purposes:

1. Checks the performance of Bench 200
2. Sets up Bench 200 for the particular equipment of OEMs

Figure 5-1 shows how the Interface Card connects to Bench 200

Figure 5-1 -- Interface Card, Cable, Bench 200



3. Measurement Instruments

A digital multimeter (DMM) can be used to make most Bench 200 test measurements.

An oscilloscope (CRO) may be used to check motor speed. And, an oscilloscope may be more convenient to use for Reference signal adjustments (described in Chapter 6) and for setting the Preamp output signal (TP1).

A frequency counter may be used for more precise measurements of motor speed.

4. Measurement Types

Test measurements fall into two categories. They are measurements that involve --

1. Readings of circuits that may be adjusted with Pots

2. Readings of circuits that can not be adjusted; circuits must meet acceptability standards without adjustment by the user

5. Measurements Taken

Readings taken in Bench 200 testing are all of voltages, with two exceptions. The exceptions are Motor speed and the Preamp signal (TP1).

6. Test Functions according to PCB Assembly

You should check the general physical condition of each unit. (*)(**)

The following sections outline electrical test functions involved with each PCB Assembly and the Interface Card:

1. Transformer and Base Plate Assembly*

Transformer and Base Plate Assembly* has the following tests:

None: checked by Processor PCB checks

2. Power Supply(*)

The Power Supply (*) has the following tests:

None: checked by Processor PCB checks

3. Source PCB Assembly

Source PCB Assembly has the following tests:

1. Source voltage
2. Motor voltage (Optical Assembly)
3. Filter Wheel Heater voltage (Optical Ass.)

4. Cooler-Preamp

The Cooler-Preamp has the following tests:

1. Preamp signal
2. Cooler voltage

Notes: Warnings concerning physical inspections:
(*) High voltage caution
(**) Carbon monoxide inhalation

6. Test Functions according to PCB Assembly (cont'd)

5. Processor PCB Assembly

Processor PCB Assembly has the following tests:

1. Power Supply
2. CO2, HC, CO signal pedestals
3. AGC voltage
4. Motor Speed (Dark Level signal)
5. Motor Tach Signal
6. CO2, HC, and CO zero adjustability and voltage range (coarse settings)

6. Interface Card (Optional)*

Interface Card is used to test for:

1. CO2, HC, and CO zero adjustability and voltage range (fine settings)
2. CO2, HC, CO Gas Span measurement
3. CO2, HC, CO electronic calibration

Note: (*) The Interface Card is a card designed by Andros specifically for testing and adjusting Bench 200. OEMs my use their own adjustment cards or they may purhase the Andros Interface Card.

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7. Test Components of Each PCB

The Source PCB and the Cooler-Preamp have testing components and pots.

The Processor has test points, test connectors, and pots.

The Interface Card has pots and a connector.

Letter symbols and their meanings are as follows:

- o AxJx - connectors
- o Pot Rxx - Potentiometer, adjustable resistors
- o TP - test point

Testing components are described in the following sections.

1. Source PCB

Source PCB components, locations, and their test/adjust function are as follows:

1. R20 - Motor Current (C,4)
2. R6, R9 Node and C2 - Source voltage (B,4) (C,2)
3. R33 - Filter Wheel Heater voltage (C,3)
4. Pot R18 - Motor Speed (C,3)
5. Pot R3 - Source voltage (C,4)
6. SW1 - Motor switch or jumper: disconnects motor from Motor Servo control (C,3)

Figure 5-2 shows each of those test components.

Figure 5-3 shows the functional location of those components.

Figure 5-2 — Source PCB Drawing with Test Components Noted

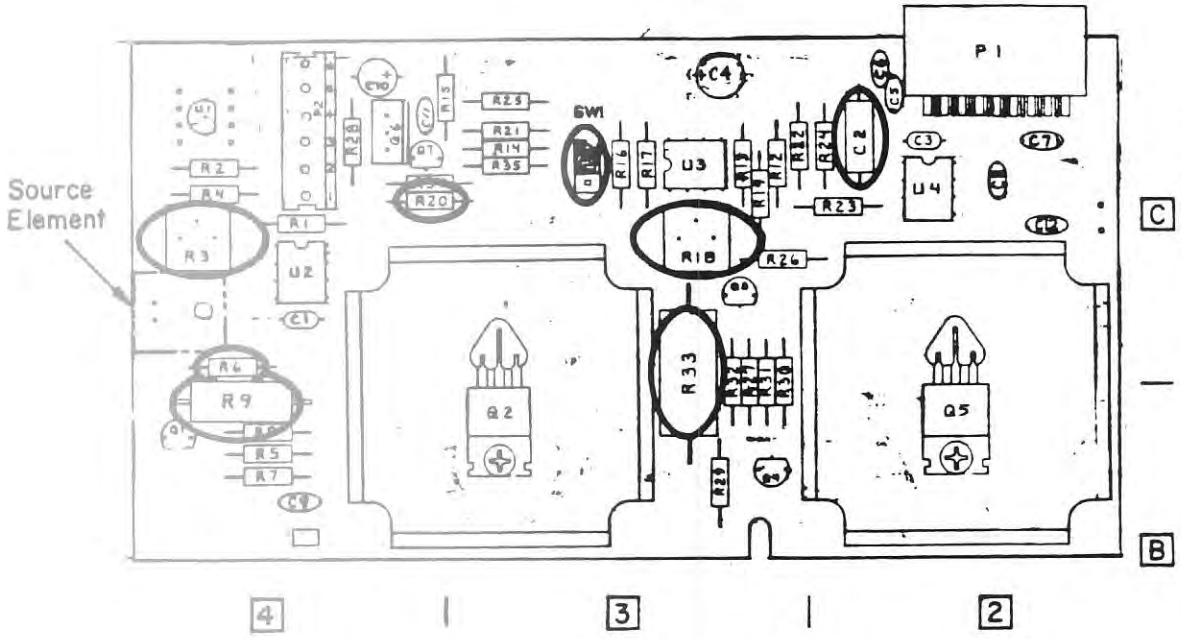

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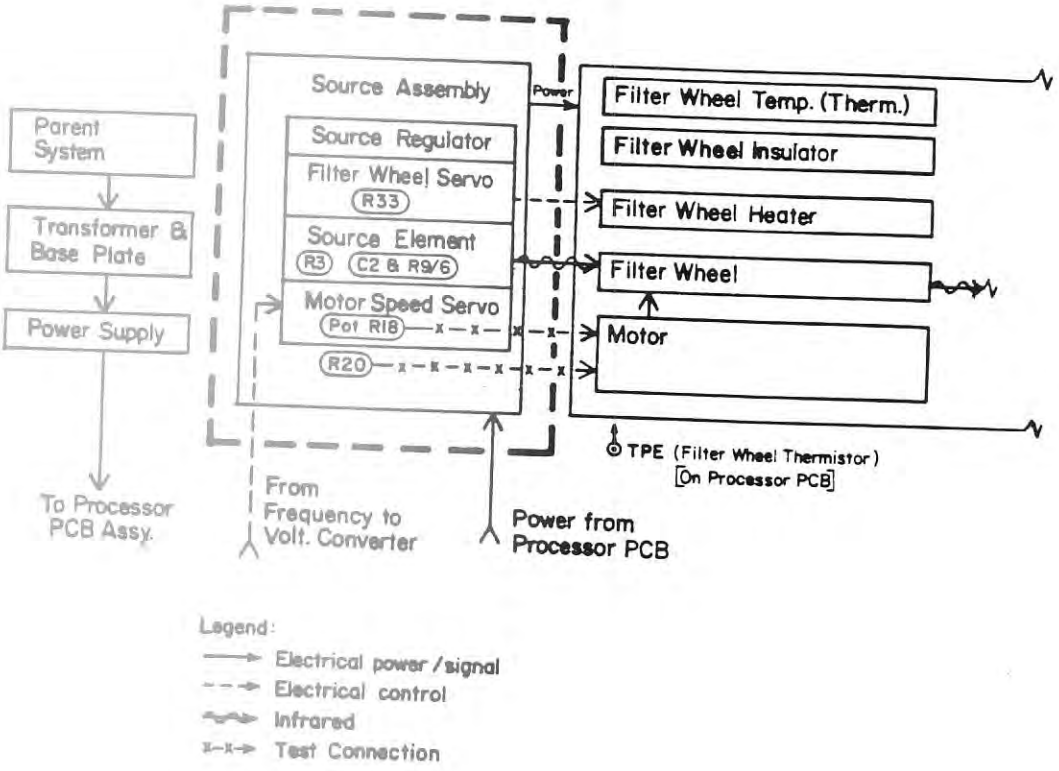
Figure 5-3 — Source PCB Diagram with Test Components Noted



7. Test Components of Each PCB (cont'd)

2. Cooler-Preamp PCB

Cooler-Preamp PCB components, their locations, and test/adjust functions are:

1. Pot R23 - Preampl-Signal Pedestal Setting

2. R11 - Detector Cooler Voltage

Figure 5-4 shows each of those test components.

Figure 5-5 shows the functional location of those components.

Figure 5-4 -- Cooler-Preamp PCB with Test Components Noted

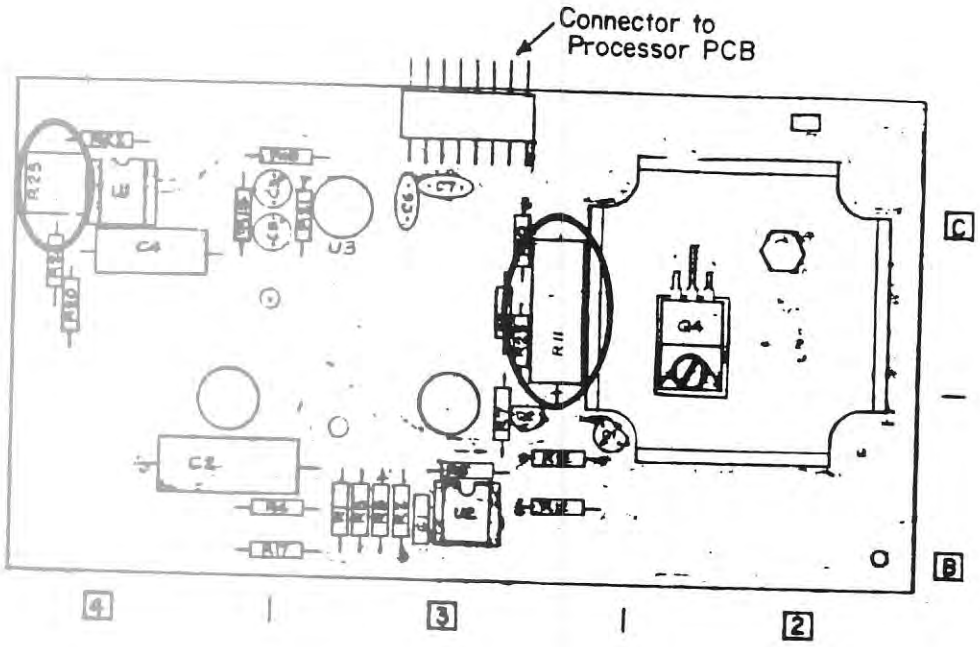


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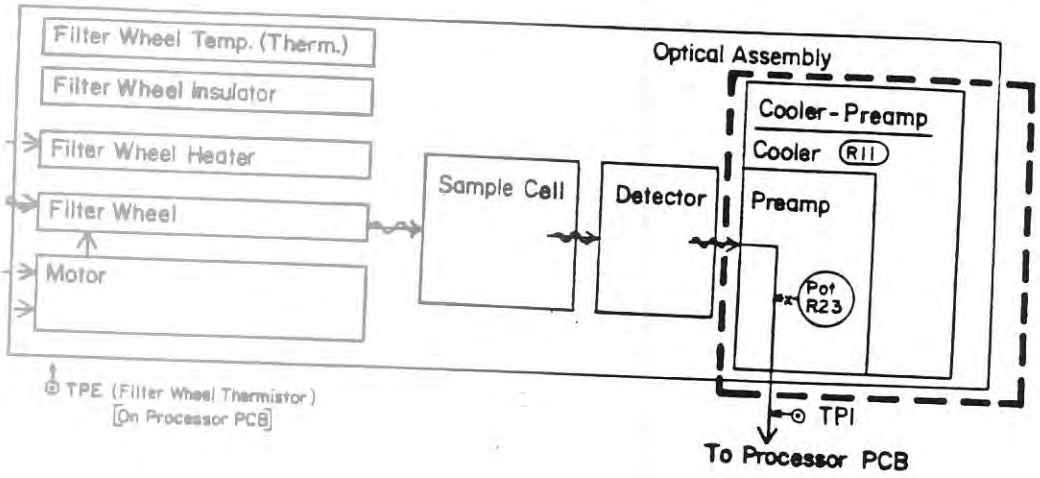
Figure 5-5 — Cooler-Preamp PCB Diagram with Test Components Noted



Legend:

- Electrical power / signal
- Electrical control
- Infrared
- Test Connection

7. Test Components of Each PCB (cont'd)

3. Processor PCB

Processor PCB components, locations, and test/ adjust functions are:

1. A1J4 (Test Connector*) - Power Supply Voltages (C,5)

   Pin 2 - +15 volts Pin 10 - +6.5 volts
   Pin 3 - -15 volts Pin 11 - -6.5 volts

2. TPE - Filter Wheel Temperature Control (B,5)
3. TP3 - Reference CRO pedestal (C,4)

   Coarse zero adjustment for —

5. Pot R34 - CO2 (D,4)
6. Pot R31 - HC (D,4)
4. Pot R28 - CO (D,4)
7. Pot R12 - Reference (D,4)

8. TP5 - CO2 output signal voltage (B,5)
9. TP6 - HC output signal voltage (C,5)
10. TP7 - CO output signal voltage (B,5)

11. TP4 - AGC voltage (B,5)

12. DLTP - Signal frequency (trigger) (C,5)

15. TP5 with Pot R34 - CO2 zero signal output
16. TP6 with Pot R31 - HC zero signal output
14. TP7 with Pot R28 - CO zero signal output

17. TP5 with Pot R67 - CO2 zero signal output; used with optional Interface Card for coarse adjustments (B,3)

18. Pots R58, R80, R82 - Factory adjustment for crosstalk interference (B,3/4)

19. GNDTP - Ground (C,2)

Figure 5-6 shows each of those test components.

Figure 5-7 show the functional locations of those components.

Note:(*) The A1J4 Test Connector may be used to do other tests also. See Appendix E.

Figure 5-6 — Processor PCB Drawing with Test Components Noted

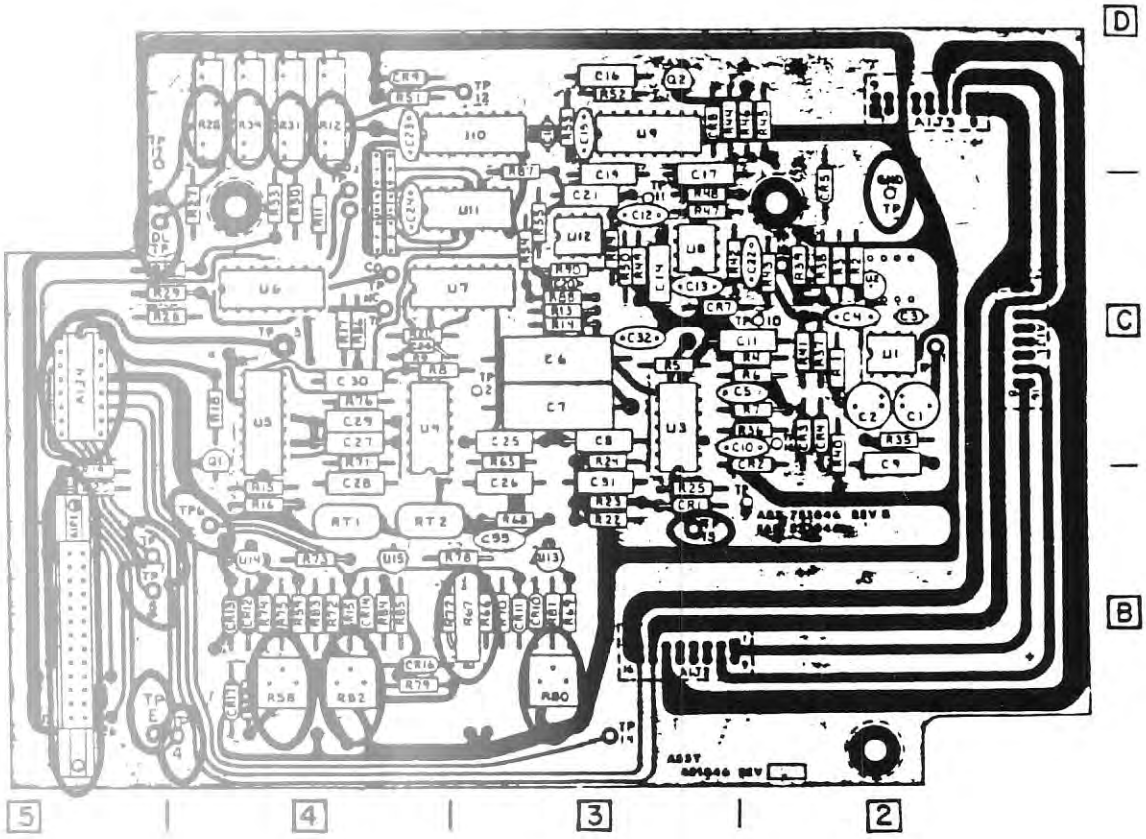


Figure 5-7 (Sheet 1) — Processor PCB Diagram with Test Components Noted

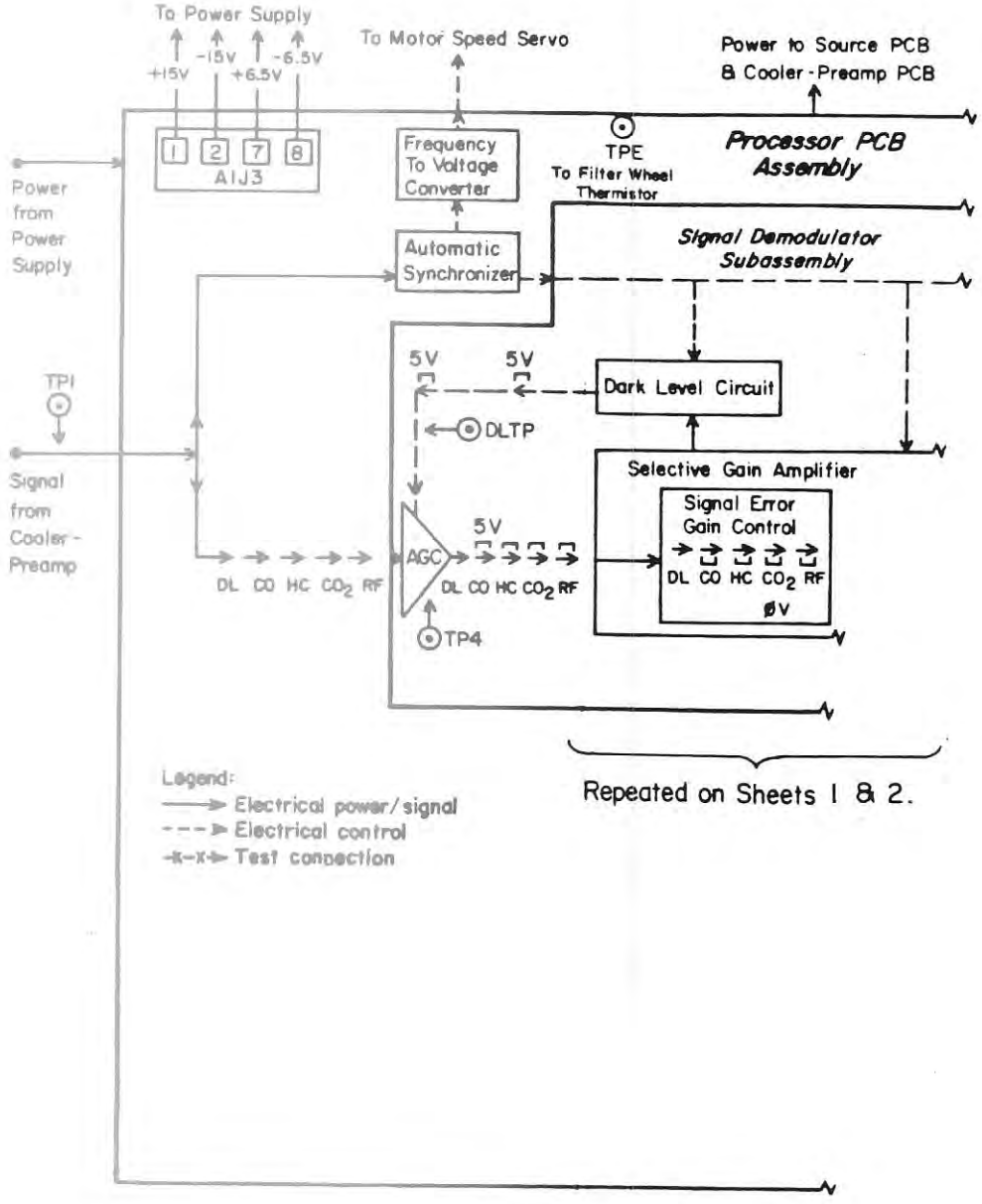
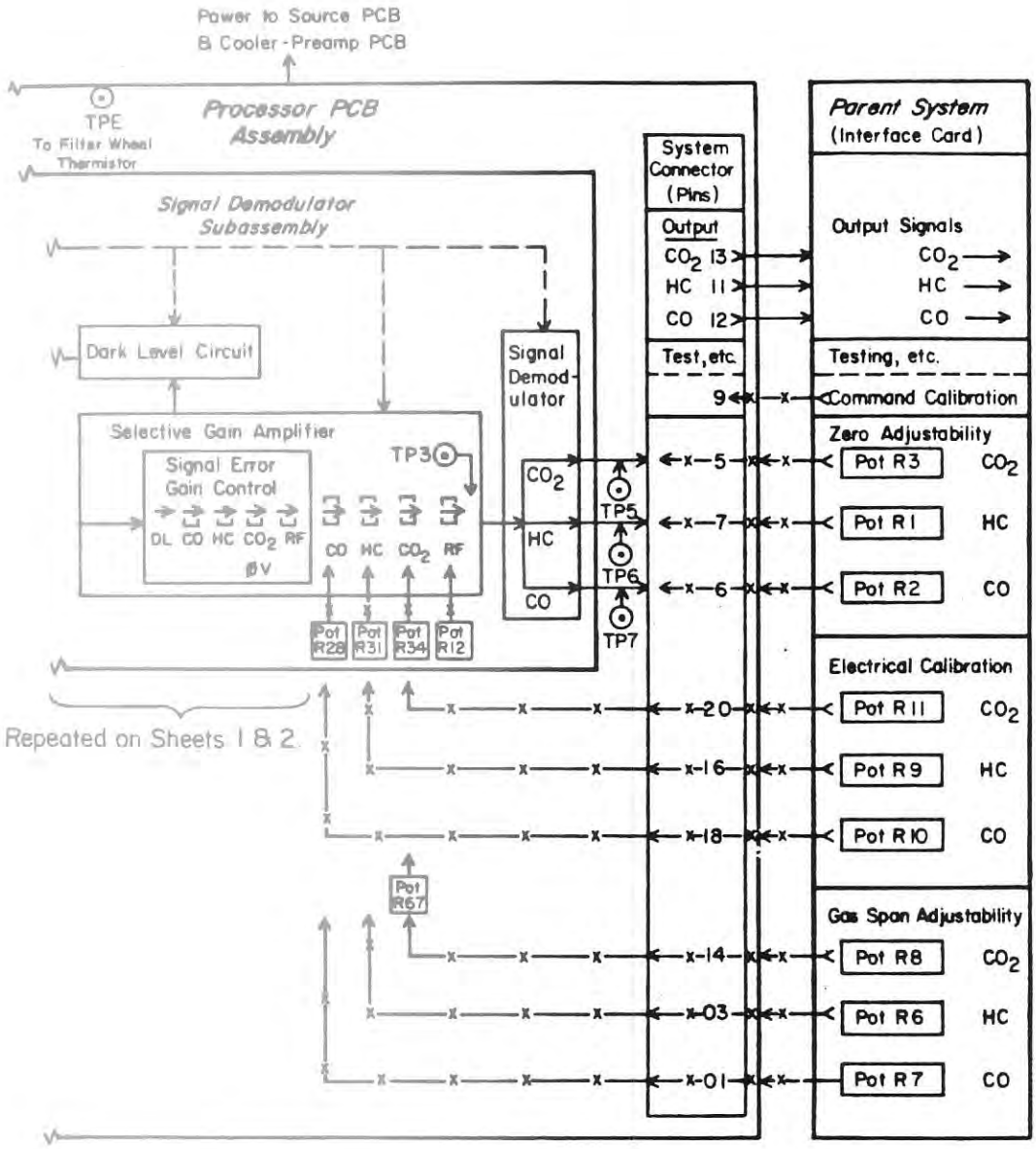


Figure 5-7 (Sheet 2) — Processor PCB Diagram with Test Components Noted



7. Test Components of Each PCB (cont'd)

4. Customer Interface Adjustments*

Interface Card Adjustments are made using test points on the Processor Board for CO2 signal (TP5), the HC signal (TP6), and the CO signal (TP7).

Interface Card test components, locations, and test/adjust functions are:

1. Pot R3 (B,2) - CO2 zero adjustability, voltage range: 0 +/- 2.0 volts (TP5)

2. Pot R1 (B,2) - HC zero adjustability, voltage range: 0 +/- 2.0 volts (TP6)

3. Pot R2 (B,2) - CO zero adjustability, voltage range 0 +/- 2.0 volts (TP7)

4. Pot R8 (B,3) - CO2 voltage span check with calibration gas, +/- 15% adjustability about a fixed calibration point (TP5)

5. Pot R6 (B,2) - HC voltage span check with calibration tion gas, +/- 15% adjustability about a fixed calibration point (TP6)

6. Pot R7 (B,2) - CO voltage span check with calibration gas, +/- 15% adjustability about a fixed calibration point (TP7)

7. Pot R11 (B,3) - CO2 electronic calibration: 10 volts +/- 1.5 volts (TP5)

8. Pot R9 (B,3) - HC electronic calibration, voltage 10 volts +/- 1.5 volts (TP6)

9. Pot R10 (B,3) - CO electronic calibration, voltage 10 volts +/- 1.5 volts (TP 7)

Figure 5-8 shows each of those test components.

Figure 5-9 shows the functional location of those components.

Note: (*) The Interface Card is a card designed by Andros specifically for testing and adjusting Bench 200. OEMs my use their own adjustment cards or they may purhase the Andros Interface Card.

Figure 5-8 — Interface Card Drawing with Test Components Noted

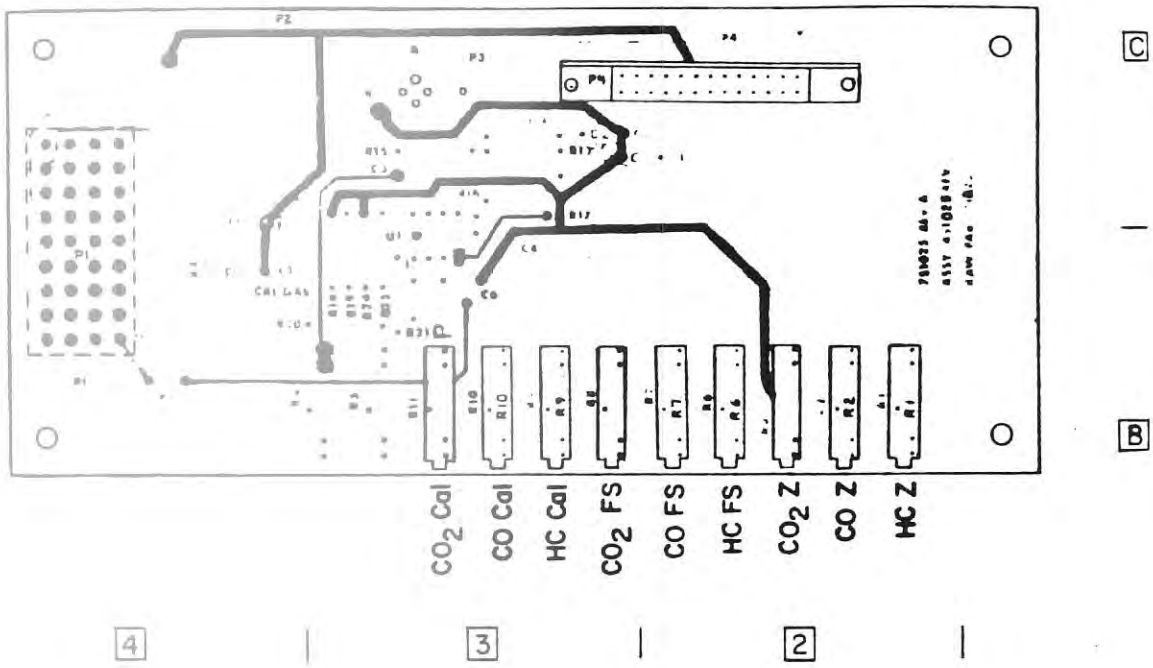


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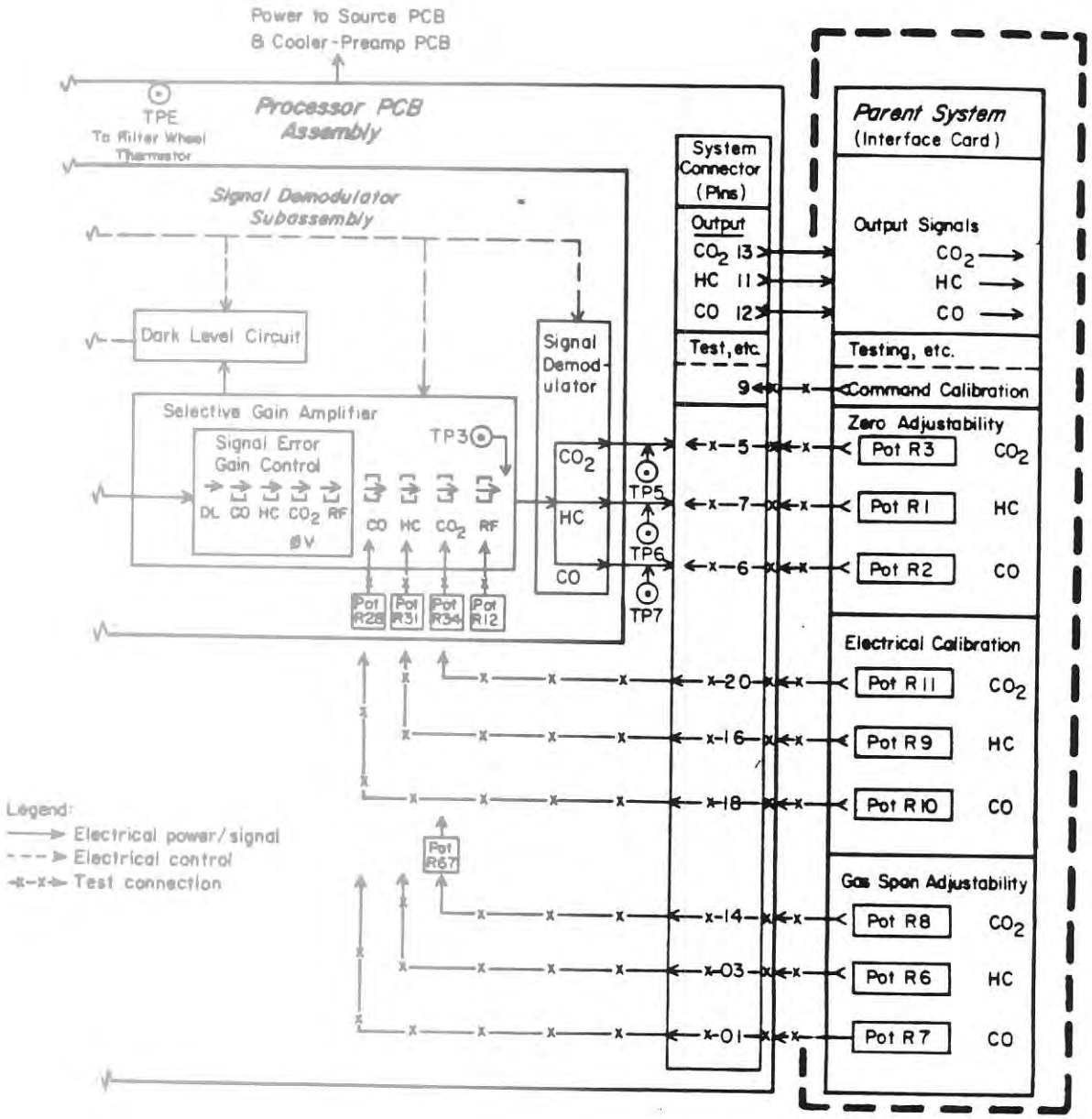
Figure 5-9 — Interface Card Diagram with Test Components Noted



Chapter 6 -- Testing Procedures

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Overview

This chapter has three of its five sections about testing procedures:

- Summarized Test Procedures
- Detailed Test Procedures
- Abbreviated Test Procecedures

Detailed Test Procedures should be used when you are first learning about Bench 200. You may find it convenient to use the Summarized Test Procedures for a full test for troubleshooting and confirmation of repairs.

You should use the Detailed Test Procedures when troubleshooting (Chapter 7) and when you want to be certain of direct measurements for all key components in the system.

The Abbreviated Test Procedures include key parts of the test procedures. If a unit meets the test requirements of the Abbreviated Test Procedures, that unit is ready to be installed into the final product.

1. Test Equipment, Material, Precautions

1. Equipment Needed

1. Screwdriver (Phillips Head)
2. Screwdriver (Slot)
3. Digital Multimeter (DMM)
4. Oscilloscope (CRO) (Dual Trace)
5. Interface Card (Int. Card) or equivalent

2. Material

Calibration gases: CO2, Hexane* (for HC), CO, N2

3. Precautions

1. Do not contact high voltage connections between the Bench 200 and line power
2. Ensure adequate ventilation
3. Ensure adequate airflow over Bench 200 during testing (250 LPM airflow)

Note:(*) Propane may be used instead of hexane if a Propane Equivalency Factor (PEF) is also used. See End of Chapter Note for using Propane as a calibration gas

2. Summary Test Procedures

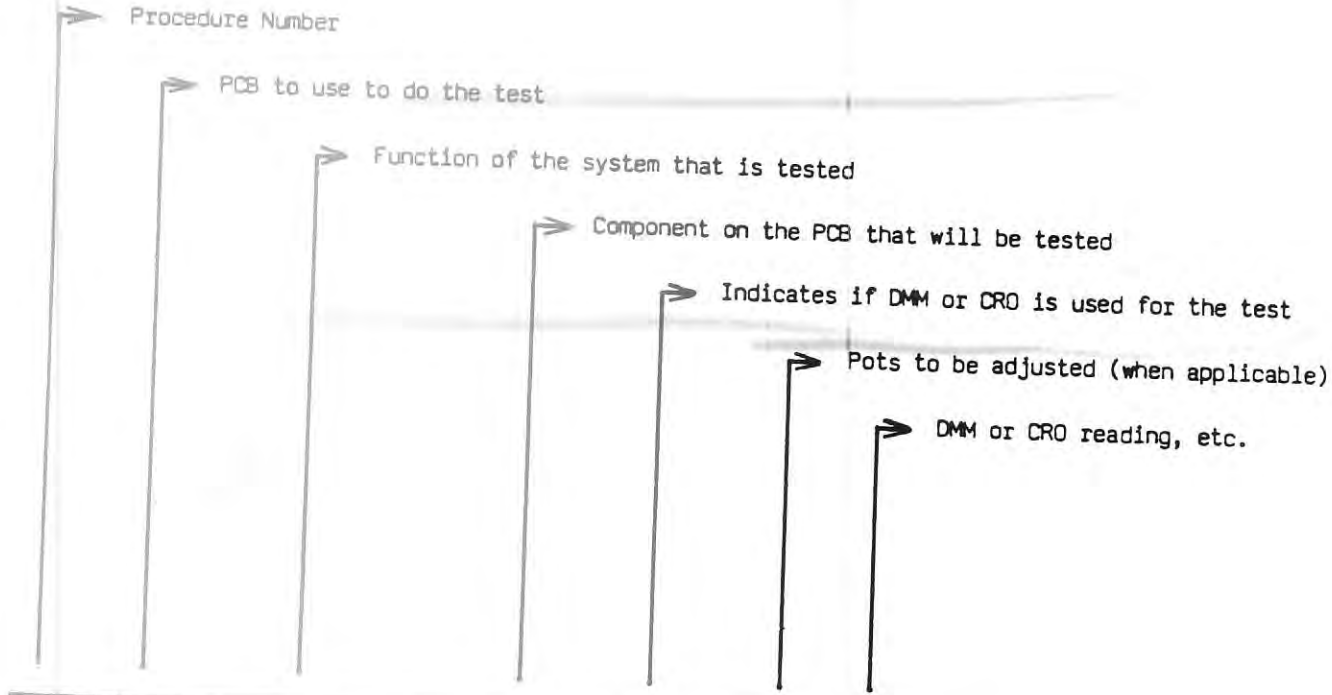
The summarized Testing Procedures are described first only so that the first-time user may see in one page an overview of the lengthy Detailed Testing Procedures covered in Section 3.

The Summary Test Procedures should be used only after you are thoroughly familiar with the Detailed Testing Procedures. The Summary Testing Procedures are only a memory aid for those who have performed the detailed testing procedures many times.

The general order of the test procedures is first according to power and signal flow, by PCB. Then, the procedures are grouped according to the measurement instrument used, digital multimeter (DMM) or cathode ray oscilloscope (CRO).

Table 6-1 contains the Summary Test Procedures.

An explanation of the headings in Table 6-1 is outline below.



Proc. No.	PCB to be Checked	Function To Be Checked	Item Checked	DMM/ CRO	Pots Adjust.	DMM/CRO Reading, Range, Remarks

* BEST PROCEDURE

Table 6-1 - Summary Test Procedures

(To be done after physical inspection and 10 minute warmup)

	PCB to be Checked	Function To Be Checked	Item Checked	DMM/ CRO	Pots Adjust.	DMM/CRO Reading, Range, Remarks
1.	—					Setup for Test Procedures
2.1	Processor	Power Supply	A1J4	DMM	—	Read voltages at pins 2, 3, 10, 11 +15 -15 +7 -7
2.2	Source	Motor Current	R20	DMM	—	Read: 0.4 volts +/- 0.08 volts
2.3	Source	Source Voltage	R9/6, C2	DMM	—	Read: +7.7 to +7.9 V W/Respect to -
2.4	Source	Filter Wheel Heater Voltage	R33	DMM	—	Read: 0.2 volts to 0.8 volts across resistor
2.5	Source	Motor Speed	DLTP	CRO*	Pot R18	Set to 10.53 ms +/- 0.12 ms
3.1	Cooler-Preamp	Preamp Signal	TP1 (on Processor PCB)	CRO	Pot R23	Adjust the largest signal to 300mV +/-20mV
3.2	Cooler-Preamp	Cooler Current	R11	DMM	—	Read: +0.6 to +1.25 volts
4.1	Processor	Reference:	TP3	—	—	—
		Pedestal: CO2		CRO	Pot R34	Adjust signal to maximum size*
		Pedestal: HC		CRO	Pot R31	Adjust signal to maximum size*
		Pedestal: CO		CRO	Pot R28	Adjust signal to maximum size* (Note:(*) peak-to-peak)
		All Pedestals		CRO	Pot R12	Adjust the smallest pedestal to ?? 200mV +/- 50mV peak-to-peak
4.2	Processor	Zero O/P: CO2	TP5	DMM	Pot R34	Set 0.0V+/-0.1V
		Zero O/P: HC	TP6	DMM	Pot R31	Set 0.0V+/-0.1V
		Zero O/P: CO	TP7	DMM	Pot R28	Set 0.0V+/-0.1V
4.3	Processor	AGC Voltage	TP4	DMM	—	Read:+2.5 to 3.1V

5700 RPM on ACE

No TP1 on Processor PCB

USE SCOPE

SET LINE PO 3-19

Note: (*) Use of frequency counter optional

CALIB PCBA

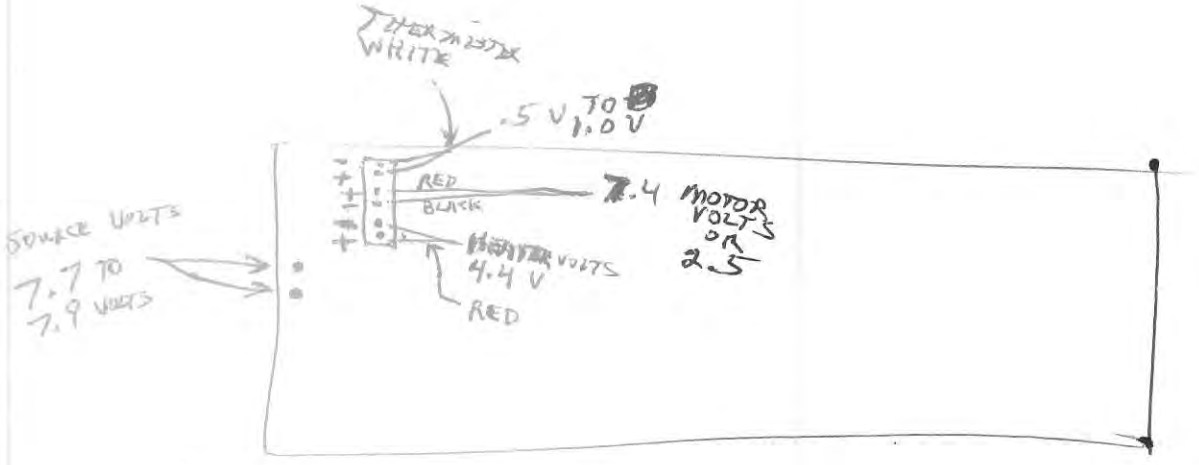
50K R_1, 25K R_2, 25K R_3 — 30 TURN POTS SET TO 15

100K R_4, 50K R_5, 50K R_6 — 30 TURN SET TO 15

AFTER R_1, R_2, R_3 ARE CENTERED AT 15 TURNS PUT HC, CO, & CO2 AT THE SAME HEIGHT USING POTS ON PROCESSOR BOARD. THEN WITH REF PDT BRING THEM TO ZERO ON METER SHOWING POT #1.

Table 6-1 -- Summary Test Procedures (cont'd)

Proc. No.	PCB to be Checked	Function To Be Checked	Item to Check	DMM/ CRO	Pots to Adjust.	DMM/CRO Reading, Range, Remarks
					Int.Card	
5.1	Processor	Zero Adj: CO2	TP5	DMM	Pot R3	Range: set each equal to or
5.2	Processor	Zero Adj: HC	TP6	DMM	Pot R1	less than -2.0 volts;
5.3	Processor	Zero Adj: CO	TP7	DMM	Pot R2	set each equal to or greater than +2.0 volts
						Set each at 0.0 V +/-0.05V
5.4	---					Gas Span Test Setup
					Int.Card	
5.5	Processor	Gas Span: CO2	TP5	DMM	Pot R8	Check adjustability from nominal
5.6	Processor	Gas Span: HC	TP6	DMM	Pot R6	voltage; then set at nominal
5.7	Processor	Gas Span: CO	TP7	DMM	Pot R7	voltage for each gas
5.8	---					Flush Sample Cell
5.9	---					Setup for Electronic Calibration
					Int.Card	
5.10	Processor	Elec.Cal: CO2	TP5	DMM	Pot R11	Check range less than 8.5 V
5.11	Processor	Elec.Cal: HC	TP6	DMM	Pot R9	Check range greater than 11.5 V
5.12	Processor	Elec.Cal: CO	TP7	DMM	Pot R10	Set each Pot to +10V +/-0.05 V



3. Detailed Test Procedures

Overview of Detailed Test Procedures

Detailed Test Procedures first test the power supply and then complete each step for tests that involve the —

1. Source PCB
2. Cooler-Preamp PCB
3. Processor PCB
4. Processor PCB with Interface Card

The following figures show the test components that are described in the sections below:

1. Figure 6-1 - Source PCB Drawing with Test Components
2. Figure 6-2 - Cooler-Preamp PCB Drawing with Test Components
3. Figure 6-3 - Processor PCB Drawing with Test Components
4. Figure 6-4 - Interface Card Drawing with Test Components

Locations of test parts on each figure are shown in parentheses just after, or just below, the name of each part mentioned. For example -

TP1 (B,5)

TP15
(B,3)

For the component "TP15", the letter "B" is for the vertical location on the figure. The number "3" is for the horizontal location on the figure.

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Figure 6-1 - Source PCB with Test Components

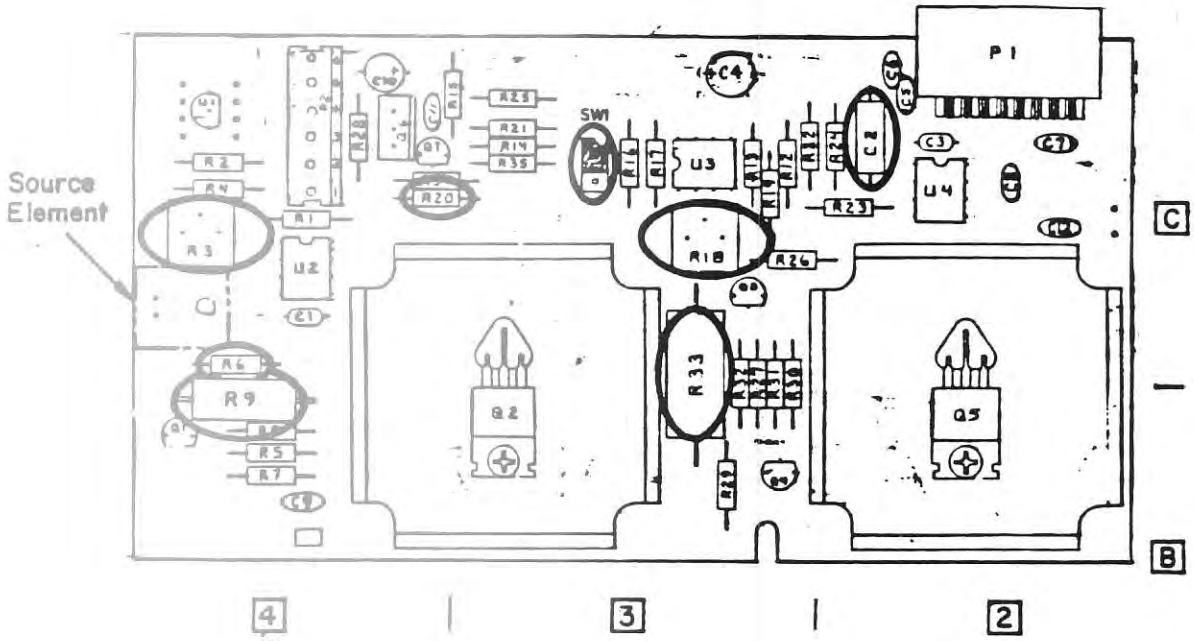

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Figure 6-2 -- Cooler-Presamp PCB with Test Components

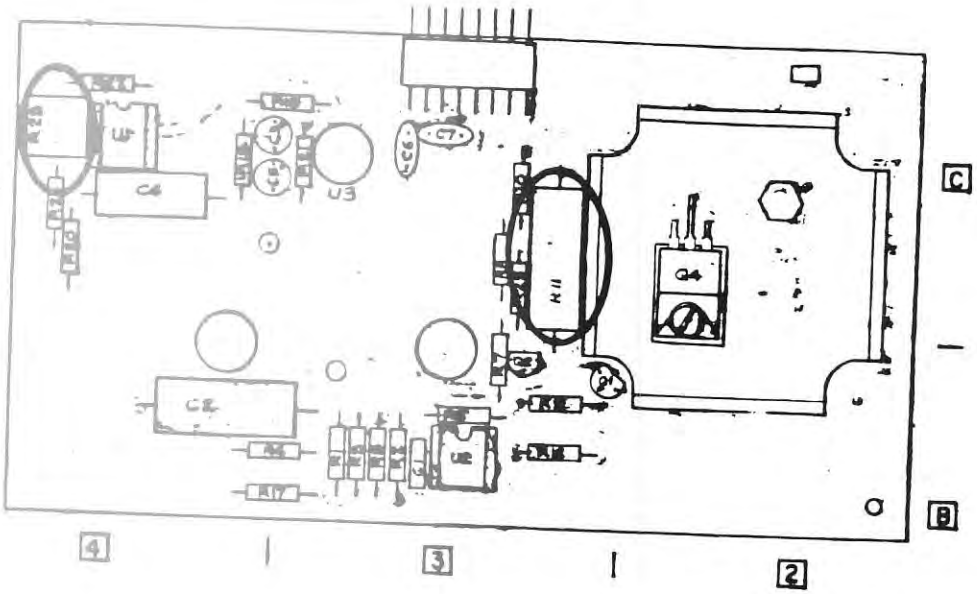

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Figure 6-3 -- Processor PCB with Test Components

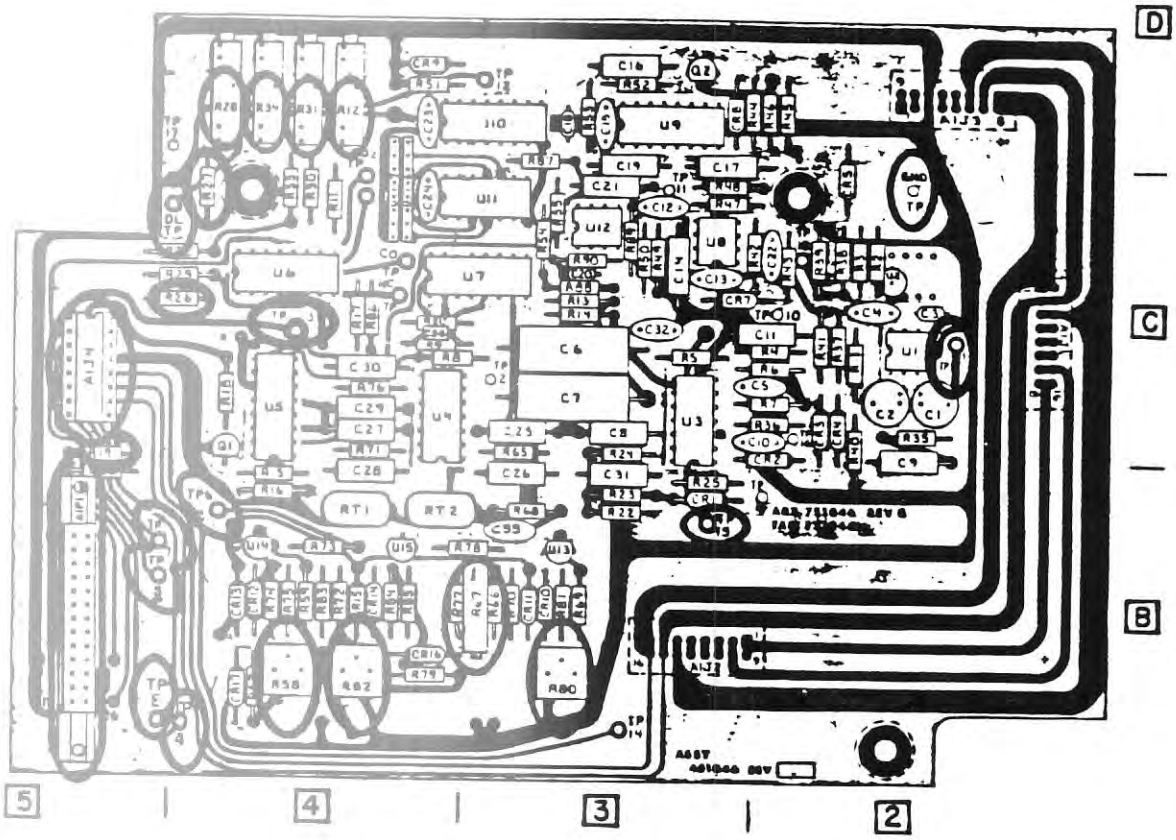

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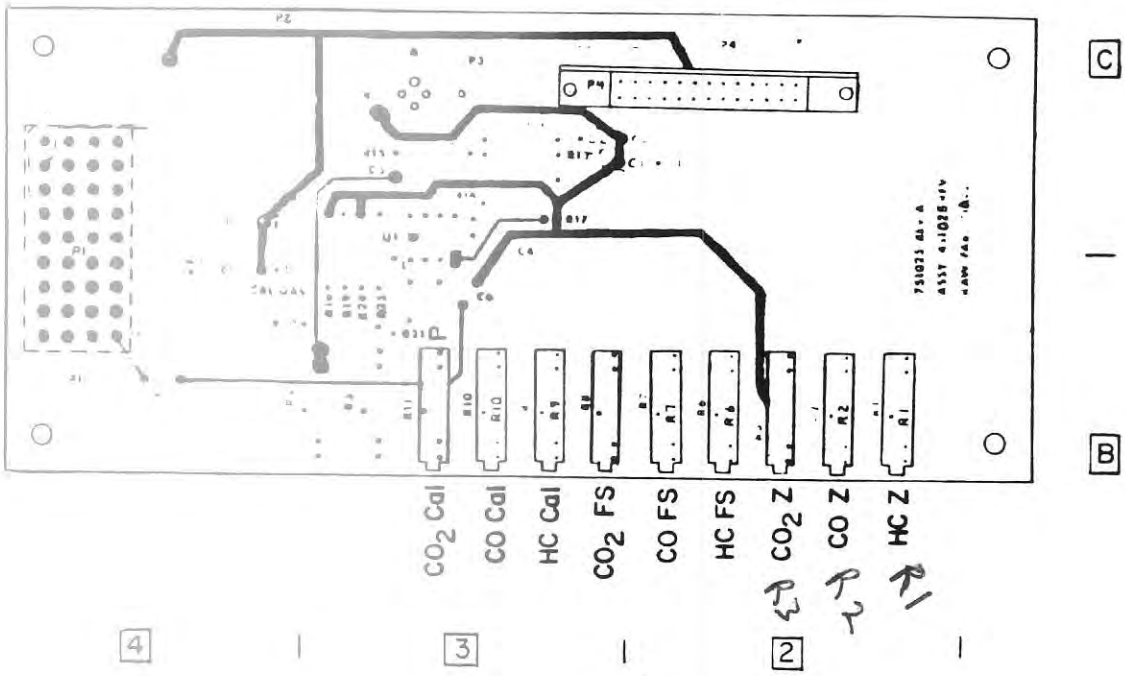
Figure 6-4 -- Interface Card Drawing

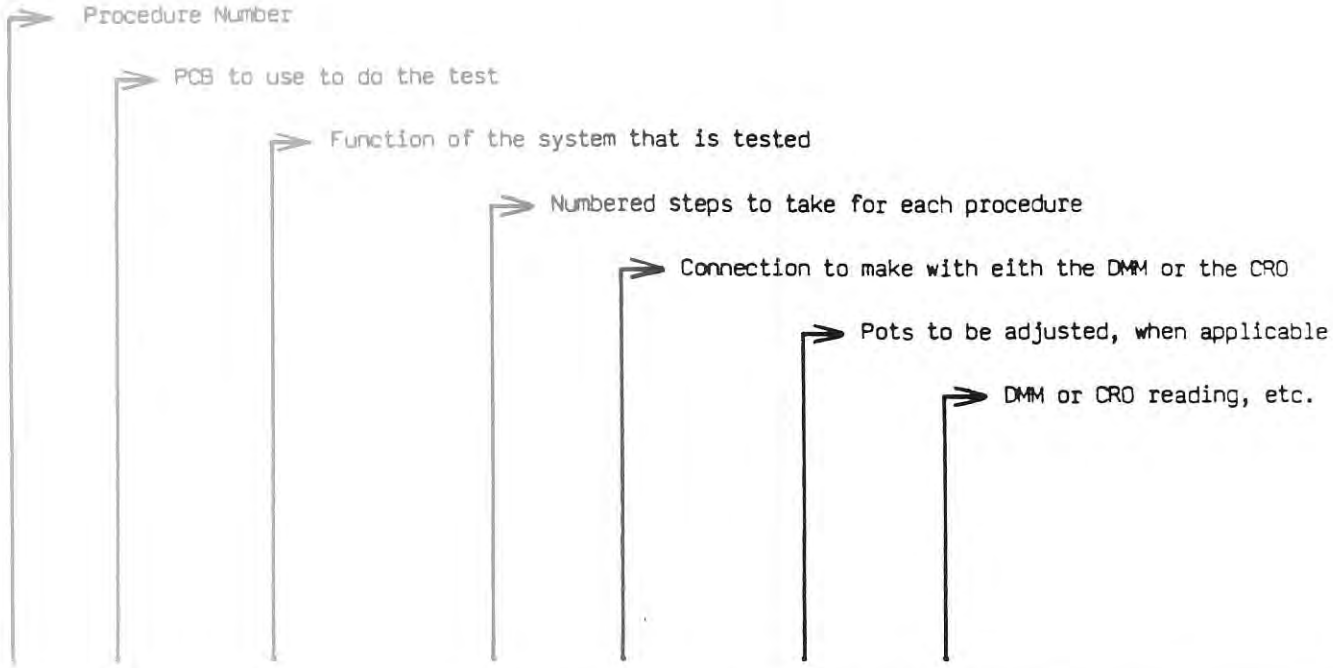
WE DON'T HAVE -
TECH SERVICE MAN



3. Detailed Test Procedures (cont'd)

Sections below contain step by step test procedures.

An explanation of the headings for the section is in the outline below.



Proc. No.	PCB to be Checked	Function To Be Checked	Step No.s	DMM/CRO Conn: Minus* Plus	Adjust. Control	DMM/CRO Reading, Range, Remarks

BC-6 BETTER PROCEDURE

3. Detailed Test Procedures (cont'd)

1. Setup for Test Procedures

Proc. No.	PCB to be Checked	Function To Be Checked	Step No.s	DMM/CRO Conn: Minus*	Plus	Adjust. Control	DMM/CRO Reading, Range, Remarks
1.	General		1.	N/A		N/A	1. Bench 200 power ON 2. Check Int.Card disconnected
2.	Int.Card	Interface Card: Center zero pots: CO2	1.	25*		N/A	Ground
			2.		5	POT R3 (B,3)	12.5 ohms
		HC	3.		7	POT R1 (B,4)	25 ohms
		CO	4.		6	POT R2 (B,9)	12.5 ohms
3.	Int. Card	General	1.	N/A		N/A	Connect Int. Card to Processor A1P1
4.	Processor	Oscilloscope (CRO Setup) SEE MY DRAWING FOR SIGNALS					CRO Connections: --- Channel 1 (Preamp Signal) Channel 2 (Composite Sig.) Trigger
				TP1 (C,2)			
				TP3 (C,4)			
				DLTP (C,4)			
5.	Source	Motor Servo Connection	1.	N/A		N/A	Ensure that switch SW1 is UP or top two pins are jumpered
6.	General		1.	N/A		N/A	Check elapsed time since power ON: must be at least 10 minutes

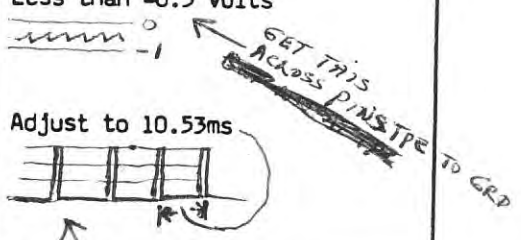
Note: (*) All measurements are to ground unless otherwise specified.

SEE Pg 3-19

3. Detailed Test Procedures (cont'd)

2. Test Using Processor PCB (Power Supply), Source PCB

Proc. No.	PCB to be Checked	Function To Be Checked	Step No.s	DMM/CRO Conn: Minus*	Plus	Adjust. Control	DMM/CRO Reading, Range, Remarks
				A1J4 (C,5)			
1.	Processor	Power Supply	1.	Pin 4		N/A	+/- 15 volt ground
			2.		Pin 2	N/A	+15 volts
			3.		Pin 3	N/A	-15 volts
			4.	Pin 13			+/- 6.5 volt ground
			5.		Pin 10	N/A	+6.5 volts
			6.		Pin 11	N/A	-6.5 volts
2.	Source	Motor Volts	1.	Across R20 (C,4)		N/A	0.4 volts
3.	Source	Source Volts	1.	Top of C2 (C,2)	R6/9 (node) (B,4)	Pot R3 (C,4)	7.8V +/- 0.05V ACROSS SOURCE EASIEST WAY
4.	Source	Filter Wheel Heater Voltage	1.		TPE (B,4)	N/A	Less than -0.5 volts
5.	Source	Motor Speed Adjustment To 95 Hz 5700 RPM	1.		DLTP (C,4)	Pot R18 (C,3)	Adjust to 10.53ms



CHECK SIGNALS ON PROCESSOR PCBA

Note: (*) All measurements are to ground unless otherwise specified.

TO CHECK USING TACH ON MAIN SCOPE SELECT:

- ☐ FROM MAIN MENU GO TO SET UP SCREEN
- ☐ CHANGE # OF CYL - SELECT (2) CYL
- ☐ CHANGE PRI CIR. - SELECT PRI
- HIT CONTINUE
- SELECT ADJ SCREEN OR ANY RPM SCREEN

HOOK BLUE COIL LEAD TO DLTP TERMINAL

HOOK WHITE LEAD TO GROUND

3. Detailed Test Procedures (cont'd)

3. Test Procedures Using Cooler-Preamp PCB

Proc. No.	PCB to be Checked	Function To Be Checked	Step No.s	DMM/CRO Conn: Minus	DMM/CRO Conn: Plus	Adjust. Control	DMM/CRO Reading, Range, Remarks
1.	Cooler-Preamp	Preamp Signal	1.		TP1 (C,2)	Pot R23 (C,4)	Identify largest signal; set it to 300 millivolts +/- 20 mV
2.	Cooler-Preamp	Cooler Current	2.	Top of R11 (C,3)	Bottom of R11 (C,3)	N/A	Minimum: 0.6 V Maximum: 1.25 V

USE PIN 5,13 ON A1J1 PROCESSOR PCBA
ADJ R 23 ON COOLER

GO TO PAGE 6-21

REF CO_2 HC CO

3. Detailed Test Procedures (cont'd)

4. Test Procedures Using Processor PCB

Proc. No.	PCB to be Checked	Function To Be Checked	Step No.s	DMM/CRO Conn: Minus Plus	Adjust. Control	DMM/CRO Reading, Range, Remarks
1.	Processor	Signal Scale Setting	1.	GRN TP TP3 (C,2) (C,4)	N/A	
	CO2		2.		Pot R34 (D,4)	Adjust pedestal to maximum size
	HC		3.		Pot R31 (D,4)	Adjust pedestal to maximum size
	CO		4.		Pot R28 (D,4)	Adjust pedestal to maximum size
	REF		5.		Pot R12 (D,4)	Identify the smallest pedestal:
2.	Processor	Output signals set to zero:				
		CO2	1.	N/A	Pot R34 (D,4)	Set CO2 ped. 0.00 V +/- 0.01 V
		HC	2.	N/A	Pot R31 (D,4)	Set HC ped. 0.00 V +/- 0.01 V
		CO	3.	N/A	Pot R12 (D,4)	Set CO ped. 0.00 V +/- 0.01 V
3.	Processor	AGC Voltage	1.	TP4 (B,4)	N/A	Range: + 3.1 V to +2.5 V

SEE DRAWING ON 3-19 AND SET ACCORDINGLY

SET TO 200 MV SEE PG. 6-6

SHOULD BE + (POS 2.5 TO 3.1)

3. Detailed Test Procedures (cont'd)

5. Tests Using Processor PCB and Interface Card

Proc. No.	PCB to be Checked	Function To Be Checked	Step No.s	DMM/CRO Conn: Minus	DMM/CRO Conn: Plus	Adjust. Control	DMM/CRO Reading, Range, Remarks
1.	Processor/ Int. Card	CO2 Zero Adjustability	1.	GNDTP (C,2)	N/A	N/A	N/A
	Processor		2.		TP5 (B,5)	N/A	N/A
	Int. Card	Fine Adjust	3.			Pot R2 (B,2)	Set full CCW* to get less than -2.20 volts If in range, go to step 6. If not in range, go to step 4.
			4.				Leave Pot R2 at full CCW
	Processor	Coarse Adjust	5.			Pot R34 (D,4)	Set to -2.4 V
	Int. Card	Fine Adjust	6.			Pot R2 (B,2)	Set full CW* to get greater greater than +2.20 volts If in range, go to procedure 2. If not in range, go to step 6
	Int. Card		7.			Pot R2 (B,2)	Leave Pot R2 at full CW position
	Processor	Coarse Adjust	8.			Pot R34 (D,4)	Set to +2.4 V

Notes: (*) CCW - counterclockwise
CW - clockwise

3. Detailed Test Procedures (cont'd)

5. Tests Using Processor PCB and Interface Card (cont'd)

Proc. No.	PCB to be Checked	Function To Be Checked	Step No.s	DMM/CRO Conn: Minus	DMM/CRO Conn: Plus	Adjust. Control	DMM/CRO Reading, Range, Remarks
2.	Processor/ Int. Card	HC Zero Adjustability	1.	GNDTP		N/A	N/A
	Processor		2.		TP6 (B,4)	N/A	N/A
	Int. Card	Fine Adjust	3.			Pot R1 (B,2)	Set full CCW* to get less than -2.20 volts. If in range, go to step 6. If not in range, go to step 4.
			4.				Leave Pot R1 at full CCW
	Processor	Coarse Adjust	5.			Pot R31 (D,4)	Set to -2.4 V
	Int. Card	Fine Adjust	6.			Pot R1 (B,2)	Set full CW* to get equal or greater than +2.20 V. If in range, go to procedure 3. If not in range, go to step 7
	Int. Card		7.				Leave Pot R1 at full CW position
	Processor	Coarse Adjust	8.			Pot R31 (D,4)	Set to +2.4 V

Notes: (*) CCW - counterclockwise
CW - clockwise

3. Detailed Test Procedures (cont'd)

5. Tests Using Processor PCB and Interface Card (cont'd)

Proc. No.	PCB to be Checked	Function To Be Checked	Step No.s	DMM/CRO Conn: Minus	Plus	Adjust. Control	DMM/CRO Reading, Range, Remarks
3.	Processor/ Int. Card	CO Zero Adjustability	1.	GNDTP		N/A	N/A
			2.		TP7 (B,5)	N/A	N/A
	Int. Card	Fine Adjust	3.			Pot R3 (B,2)	Set full CCW* to get equal to or less than -2.20 V. If in limits, go to step 6 If not in limits, go to step 4.
	Int.Card		4.			Pot R3 (B,2)	Leave Pot R3 at full CCW
	Processor	Coarse Adjust	5.			Pot R28 (D,4)	Set to -2.4 V
	Int. Card	Fine Adjust	6.			Pot R3 (B,2)	Set full CW* to get equal to or greater than +2.20 V. If in range, go to procedure 4. If not in range, go to step 7.
	Int.Card		7.			Pot R3 (B,2)	Leave Pot R3 at full CW position
	Processor	Coarse Adjust	8.			Pot R28 (D,4)	Set to +2.4 V

Notes: (*) CCW - counterclockwise
CW - clockwise

3. Detailed Test Procedures (cont'd)

5. Tests Using Processor PCB and Interface Card (cont'd)

Proc. No.	PCB to be Checked	Function To Be Checked	Step No.s	DMM/CRO Conn: Minus	Plus	Adjust. Control	DMM/CRO Reading, Range, Remarks
4.	---	Gas Span Test Setup	1.	N/A		N/A	Attach intake and exhaust gas tubes to the Sample Cell
			2.	N/A		Gas Cyl. Valve	Set for 4-5 liters per minute; wait for stable flow before going to next step
			3.	N/A		N/A	1. Determine gas content of the test sample gases 2. Find, in Appendix D, the voltage equal to the gas content 3. Calculate the acceptable voltage range for each gas as follows: Range: Table Voltage +/-15% Example A: for CO2 with 13.5% content Table X V: 7.943 V 15% Table X V: 1.192 V Range: 6.752 to 9.135V Example B: for HC with 800 PPM content Table Y V: 4.475 V 15% Table X V: 0.671 V Range: 3.804 to 5.146 V Example C: for CO with 8.0% content Table Z V: 8.936 V 15% Table X V: 1.340 V Range: 7.596 to 10.276 V
	Int. Card/ Processor	Gas Span Test Setup	4.	N/A	N/A	N/A	Connect Int. Card to A1P1 Connector (B,5)

Notes: (*) CCW - counterclockwise; CW - clockwise

Detailed Test Procedures (cont'd)

5. Tests Using Processor PCB and Interface Card (cont'd)

Proc. No.	PCB to be Checked	Function To Be Checked	Step No.s	DMM/CRO Conn: Minus	Plus	Pots To Adjust	DMM/CRO Reading, Range, Remarks
5.	Processor/ Int. Card	CO2 Gas Span Adjustment	1.	N/A		N/A	Note voltage range values such as example A: Voltage: 7.943 Range: 6.752 to 9.135
			2.	GNDTP (C,2)	TP5 (B,4)	Pot R8 (B,3)	Adjust to less than 9.135 volts. If in range, go to step 5. If unable with a 036 Processor, reject. If unable with a 046 Processor, do step 3.
	Int. Card		3.			Pot R8 (B,3)	Set to full CW*
	Processor	Coarse Adjust	4.			Pot R67 (B,3)	Set to 6.6 volts
	Int. Card	Fine Adjust	5.			Pot R8 (B,3)	Adjust to more than 9.135 volts. If in range, go to step 8. If out of range with a 036 Processor, reject. If out of range with a 046 Processor, do step 6.
	Int. Card		6.			Pot R8 (B,3)	Set to full CCW*
	Processor	Coarse Adjust	7.			Pot R67 (B,3)	Set to 9.2 volts
	Int. Card	Fine Adjust	8.			Pot R8 (B,3)	Set to 7.943 volts

Notes: (*) CCW - counterclockwise
CW - clockwise

3. Detailed Test Procedures (cont'd)

5. Tests Using Processor PCB and Interface Card (cont'd)

Proc. No.	PCB to be Checked	Function To Be Checked	Step No.s	DMM/CRO Conn: Minus	Plus	Pots To Adjust	DMM/CRO Reading, Range, Remarks
6.	Processor/ Int. Card	HC Gas Span Adjustment (Hexane or Propane*)	1.	N/A		N/A	Note voltage range values, as in example B -- Range: 3.804 to 5.146 volts Set to 4.475 volts
			2.	GNDTP (C,2)	TP6 (B,4)	Pot R6 (B,2)	Adjust to greater than 3.804 V
			3.				Adjust to less than 5.146 V
			4.				Set to 4.475 V
7.	Processor/ Int. Card	CO Gas Span Ajustment	1.	N/A		N/A	Note voltage range values as in example C -- Range: 7.596 to 10.276 V Set to 8.936 volts
			2.	N/A	N/A		
			3.	GNDTP	TP7 (B,5)	Pot R7 (B,2)	Adjust to greater than 7.596 V
			4.				Adjust to less than 10.276 V
			5.				Set to 8.936 V
8.	General	Cleanup (N2 purge)	1.	GNDTP	TP5 TP6 TP7	N/A	Flush Sample Cell with N2; get 0.00 V +/- 0.05 volts at TP5, TP6, TP7.

3. Detailed Test Procedures (cont'd)

5. Tests Using Processor PCB and Interface Card (cont'd)

Proc. No.	PCB to be Checked	Function To Be Checked	Step No.s	DMM/CRO Conn: Minus	Plus	Pots To Adjust	DMM/CRO Reading, Range, Remarks
9.	Processor/ Int. Card	Electronic Cal Setup					
	1. For 036 Processor		o.	N/A	N/A		1. Short R26/27 to ground (C,4)/(D,4)
	2. For 046 Processor		o.	N/A	N/A		2. Short R19/12 to ground (C,5)/(D,4)
10.	Processor/ Int. Card	CO2 Electronic Cal	1.	GNDTP (C,2)	TP5 (B,5)	Pot R11 (B,3)	Adjust to minimum of 8.5 volts
			2.				Adjust to maximum of 11.5 volts
			3.				Set to 10.00 V +/- 0.05 V
11.	Processor/ Int. Card	HC Electronic Cal	1.	GNDTP (C,2)	TP6 (B,4)	Pot R9 (B,3)	Adjust to minimum of 8.5 volts
			2.				Adjust to maximum of 11.5 volts
			3.				Set to 10.00 V +/- 0.05 V
12.	Processor/ Int. Card	CO Electronic Cal	1.	GNDTP (C,2)	TP7 (B,5)	Pot R10 (B,3)	Adjust to minimum of 8.5 volts
			2.				Adjust to maximum of 11.5 volts
			3.				Set to 10.00 V +/- 0.05 V

Detailed Test Procedures complete.

BOB BISHOP

4. Abbreviated Test Procedures

Abbreviated Test Procedures are excerpted from the Summarized Test Procedures. Paragraph numbers are the same.*

(To be done after physical inspection and 10 minute warmup)

Proc. No.	PCB to be Checked	Function To Be Checked	Item Checked	DMM/ CRO	Pots Adjust.	DMM/CRO Reading, Range, Remarks
1.	—					Setup for Test Procedures
2.1	Processor	Power Supply	A1J4	DMM	—	Read voltages at pins 2, 3, 10, 11
4.3	Processor	AGC Voltage	TP4	DMM	—	Read:+2.5 to 3.1V
5.1	Processor	Zero Adj: CO2	TP5	DMM	Int.Card: Pot R3	Range: set each equal to or less than -2.0 V; set each equal to or greater than +2.0 V Set each at 0.0 V +/-0.05V
5.2	Processor	Zero Adj: HC	TP6	DMM	Pot R1	
5.3	Processor	Zero Adj: CO	TP7	DMM	Pot R2	
	(Int. Card: offset TP5/6/7 about +/-100mV using zero adjust Pots R3/1/2)					
5.5	Processor	Gas Span: CO2	TP5	DMM	Int.Card Pot R8	Check adjustability from nominal voltage; then set at nominal voltage for each gas
5.6	Processor	Gas Span: HC	TP6	DMM	Pot R6	
5.7	Processor	Gas Span: CO	TP7	DMM	Pot R7	
5.10	Processor	Elec.Cal: CO2	TP5	DMM	Int.Card Pot R11	Check range less than 8.5 V
5.11	Processor	Elec.Cal: HC	TP6	DMM	Pot R9	Check range greater than 11.5 V
5.12	Processor	Elec.Cal: CO	TP7	DMM	Pot R10	Set each Pot to +10V +/-0.05 V

Note:(*) You should use the complete test procedures when troubleshooting (Chapter 7) and when you want to be certain of direct measurements for all key components in the system.

The Abbreviated Test Procedures include key parts of the test procedures. If a unit meets the test requirements of the Abbreviated Test Procedures, that unit will meet the other test standards for the system. This short test thus may be used for a quick check of an operating unit.

5. End of Chapter Note

Propane Substitute for Hexane

Propane calibration gas may be used in place of Hexane. Each Bench 200 labeel is marked with a Propane Equivalency Factor (PEF).

This factor is to be applied to the Propane concentration before obtaining the voltage conversion values from the HC tables. The following example is for the use of propane with a concentration of 3000 ppm with a Bench 200 with a PEF of 0.50:

Propane concentration	1,560 ppm
PEF	0.50
HC/Hexane equivalent	780 ppm

From the HC Table, Appendix D:

Nominal Ouput	4.372 volts +/-15%
Maximum Output	5.028 volts
Minimum Output	3.716 volts

Chapter 7 -- Maintenance and Repair

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Note: (*) Plus topics for --

1. Equipment Needed
2. Precautions
3. Steps To Follow

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Overview

Bench 200 does not require programmed preventive maintenance. In normal operations with ordinary care, the Bench 200 should run trouble-free without special servicing. This chapter deals with the most common servicing tasks that OEMs have encountered in the past.

The chapter deals with Maintenance levels, servicing procedures, and some troubleshooting suggestions.

1. Customer Service

Customer Service includes training (Chapter 9), assistance in parts replacement (Chapter 8), and Phone-in Assistance.

1. Phone-in Assistance

Andros provides a phone-in service for OEMs who need assistance. To get the most out of this service, you should do the following prior to calling Andros Customer Service

- o Follow the Troubleshooting Procedures (section 7)
- o Complete the Phone-in Assistance Checklist:

Phone-in Assistance Checklist

1. Company _____
2. Date _____
3. Call Number _____
4. Model/Serial No. _____
5. Date Bought _____
6. End-user operations _____

_____

7. Performance Check Defects

Check Item	Reading
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
8. _____	_____

2. Storing Bench 200

1. Complete acceptance checks (Chapter 6) prior to storing the unit.

2. Store units in their original containers.

3. Store units in a clean, dry area.

3. Maintenance Levels

Tasks to be done by OEM service technicians depends upon their level of training, servicing equipment that they have, and spares on hand. Three maintenance levels are defined as follows:

1. Level One Maintenance

OEM has not completed the Andros Bench 200 Training Course (see Chapter 9 - Administration)and lacks equivalent qualifications. Training).

Acceptance checks may be done using testing procedures as described in Chapter 6. Servicing and parts replacement should not be attempted.

If your Bench 200 fails, you should call Andros Customer Service. Customer Service will confirm that your Bench 200 should be returned for factory repair.

Spares on hand for Level One facilities should be one spare unit for each 10 operating units.

3. Maintenance Levels (cont'd)

2. Level Two Maintenance

OEM has completed the Andros Bench 200 Training Course or has equivalent qualifications. Additionally, the service technician has a fully-equipped electronics work station.

Technicians meeting Level Two Maintenance requirements are qualified to do Level One acceptance checks, clean the Sample Cell, replace the Bench 200 components listed below, and recalibrate Bench 200 after doing those tasks.

1. Transformer and Base Plate Assembly
2. Power Supply Assembly
3. Source Assembly
4. Optical Assembly
    1. Motor
    2. Sample Cell Exit (Mica) Window
    3. Cell Window O-ring
    4. Cooler-Preamp PCB (with Collector-Detector)
5. Processor PCB Assembly

Spares of complete units on hand for Level Two Maintenance should be one spare unit for every 15 operating units. Spares of replaceble parts should be determined by the OEM's data on mean-time-between-failures plus a pipeline factor.

3. Maintenance Levels (cont'd)

3. Level Three Maintenance

OEM has Level Two qualifications plus sophisticated technical facilities. OEMs should discuss their facilities with Andros Customer Service to determine their ability to do Level Three Maintenance.

Level Three Maintenance OEMs are qualified for Level Two tasks, for the replacement of lesser components, and for recalibrations equal to the Andros factory tests (not described in this manual).

Spares of complete units and parts should be determined by maintenance planning.

3. Maintenance Levels (cont'd)

4. Maintenance Procedures (Level Two)

Level Two Maintenance procedures include the Testing Procedures (Chapter 6). Servicing tasks also include --

1. Taking Down Bench 200 into assemblies
2. Taking Down the Optical Assembly for Motor replacement and cleaning the Sample Cell
3. Taking down the Sample Cell
4. Cleaning the Sample Cell Windows
    1. Replacing the Sample Cell Exit (Mica) Windows
    2. Replacing the Sample Cell Window O-ring
5. Replacing the Motor

4. Replacing Assemblies

The Bench 200 may be readily taken down for replacement of the following five major parts or assemblies:

1. Transformer
2. Processor PCB
3. Power Supply
4. Cooler-Preamp PCB (with Collector-Detector)
5. Source Assembly
6. Optical Assembly (less the Collector-Detector)
7. Motor

The sections below describe the procedures for taking the Bench 200 down to each of those assemblies.

1. Transformer Removal

1. Equipment Needed

1. Screwdriver (Phillips Head)
2. Screwdriver (Slot)

2. Precautions

1. Disconnect Bench 200 from power and the parent system

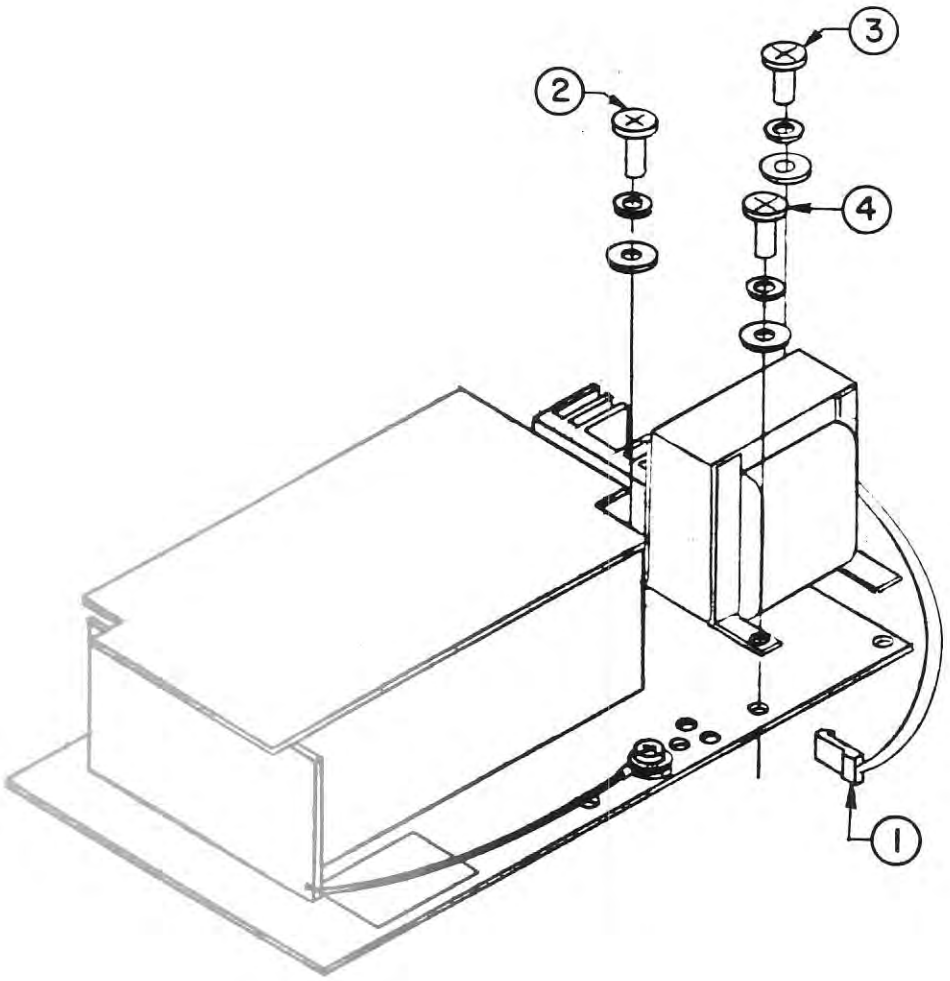
3. Steps To Follow

Figure 7-1 illustrates the following steps:

#1 On the Power Supply PCB disconnect the power connections to the power connector (1)

#2 On the Base Plate, remove screws (2), (3), and (4) that hold the Transformer to the Base Plate

Figure 7-1 -- Transformer Removal



4. Replacing Assemblies (cont'd)

2. Processor PCB Removal

1. Equipment Needed

1. Screwdriver (Phillips Head)
2. Screwdriver (Slot)

2. Precautions

1. Disconnect Bench 200 from power and the parent system

3. Steps To Follow

Figure 7-2 illustrates the following steps:

#1 On the Processor PCB, remove screws (1), (2), and (3)

#2 Detach the Processor PCB from its connectors to the Power Supply PCB, the Cooler-Preamp, and the Source PCB. Detach the PCBs in the following order:

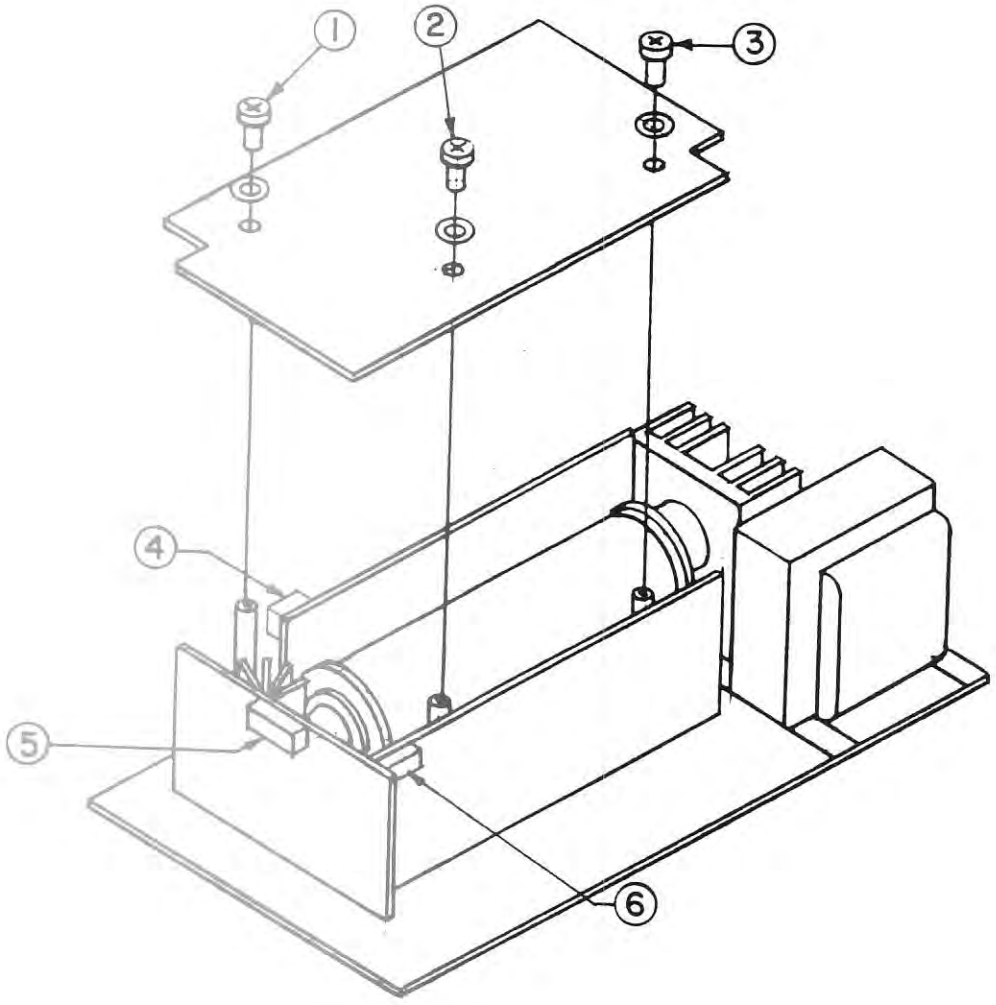
1. Source PCB (4)
2. Cooler-Preamp (5)
3. Power Supply (6)

When replacing the Processor PCB, reattach the Processor PCB in the reverse order as follows:

1. Power Supply
2. Cooler-Preamp
3. Source PCB

Note: Assure all connections line up properly.

Figure 7-2 -- Processor PCB Removal



4. Replacing Assemblies (cont'd)

3. Power Supply

1. Equipment

1. Screwdriver (Phillips Head)
2. Screwdriver (Slot)

2. Precautions

1. Disconnect Bench 200 from power and the parent system

3. Steps To Follow

Figure 7-3 illustrates the following steps:

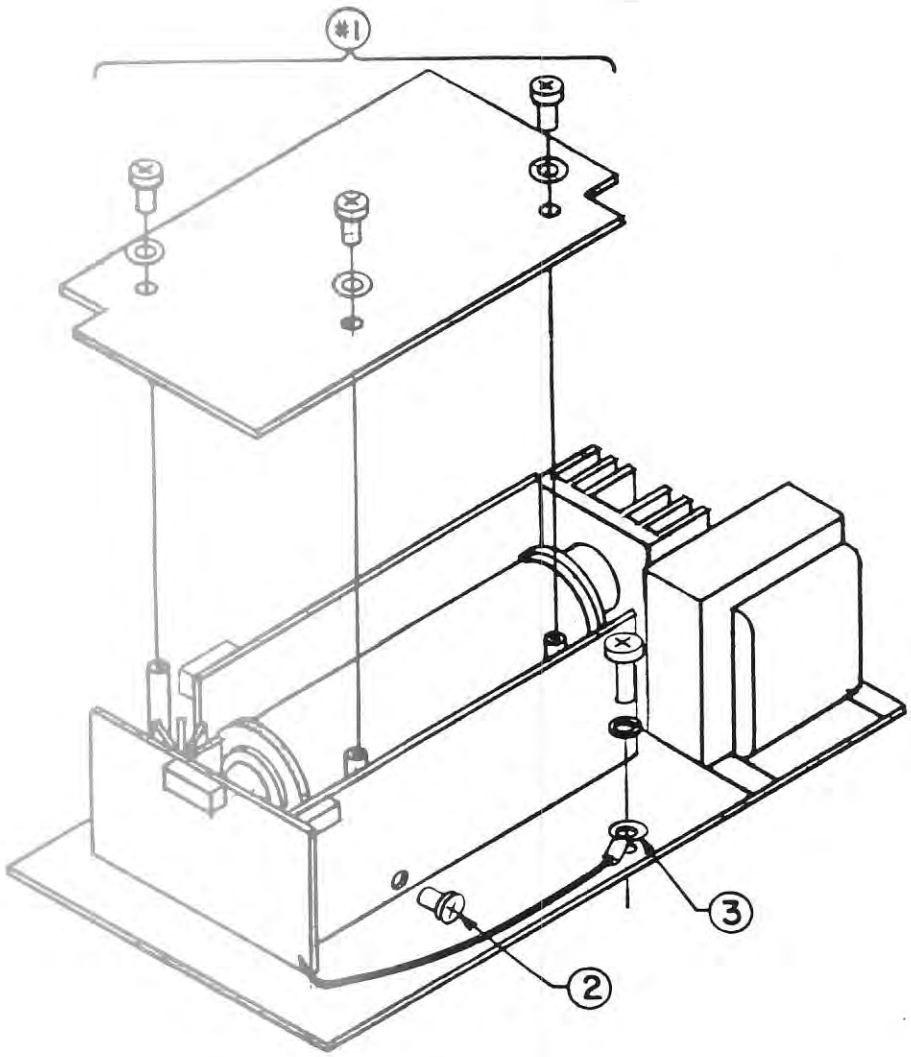
#1 Remove the Processor PCB as outlined in paragraph 4.2 above

#2 On the Power Supply PCB, remove the screw (2) holding the Power Supply PCB to the half-inch post on the Base Plate

#3 On the Power Supply, remove the screw (3) to the grounding connector between the Power Supply and the Cooler-Preamp PCB

#4 Install new Power Supply Assembly

Figure 7-3 -- Power Supply Removal



4. Replacing Assemblies (cont'd)

4. Cooler-Preamp (with Collector and Detector)

1. Equipment Needed

1. Screwdriver (Phillips Head)
2. Screwdriver (Slot)

2. Precautions

1. Disconnect Bench 200 from power and the parent system

3. Steps To Follow

Figure 7-4 illustrates the following steps:

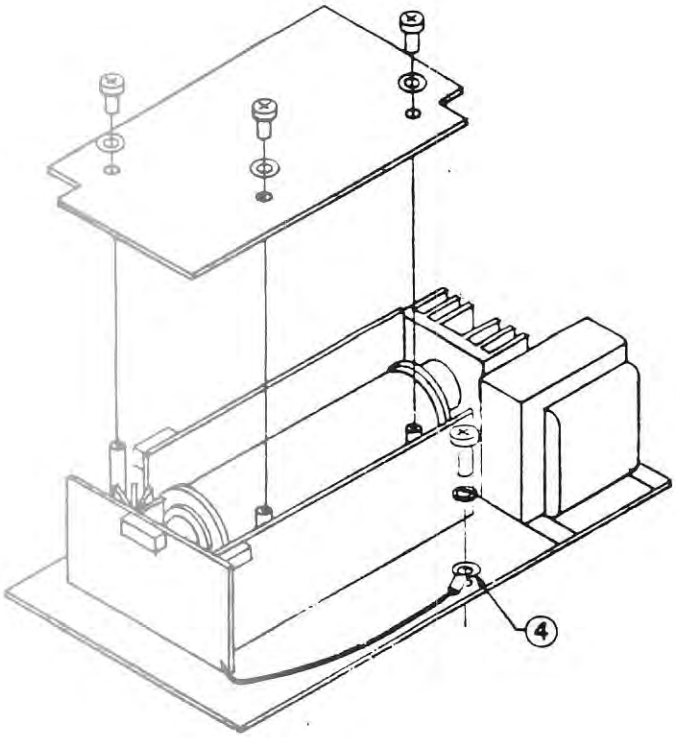
#1 Remove the Processor PCB as outlined above in paragraph 4.2 (1), (2), (3)

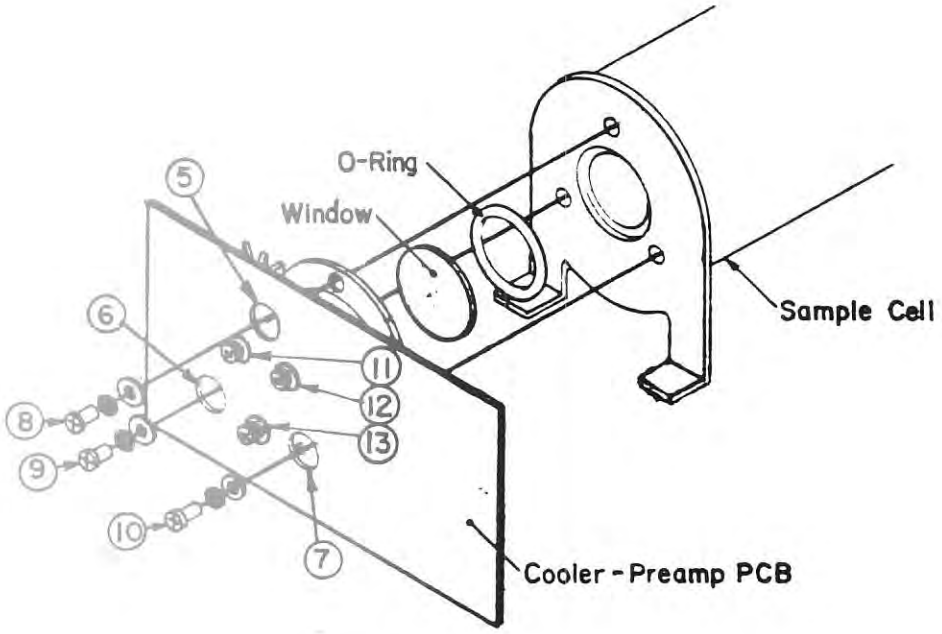
#2 On the Power Supply, remove the screw (4) to the grounding connector between the Power Supply and the Cooler-Preamp PCB

#3 Through three access holes on the Cooler-Preamp PCB (5), (6), (7), note three screws attaching the Collector to the Sample Cell (8), (9), (10). Loosen those three screws attaching the Collector to the Sample Cell

Note: Do not remove the screws that attach the Preamp PCB to the Collector (11), (12), (13) (Damage to Detector may occur)

Figure 7-4 -- Cooler-Preamp Removal





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4. Replacing Assemblies (cont'd)

4. Cooler-Preamp (cont'd)

#4 Lift of the Cooler-Preamp PCB (with Collector-Detector) from the Sample Cell:

- o Note as you remove the Cooler-Preamp that the Sample Cell Exit (Mica) Window and its O-ring do not stick together
- o Examine the Windows. Clean if they are discolored. See section 4 (Cleaning the Sample Cell Windows)

#5 After replacing the Cooler-Preamp (with Collector-Detector), reattach the Processor PCB as outlined above in paragraph 4.2.

4. Replacing Assemblies (cont'd)

5. Source PCB

1. Equipment

1. Screwdriver (Phillips Head)
2. Screwdriver (Slot)

2. Precautions

1. Disconnect Bench 200 from power and the parent system

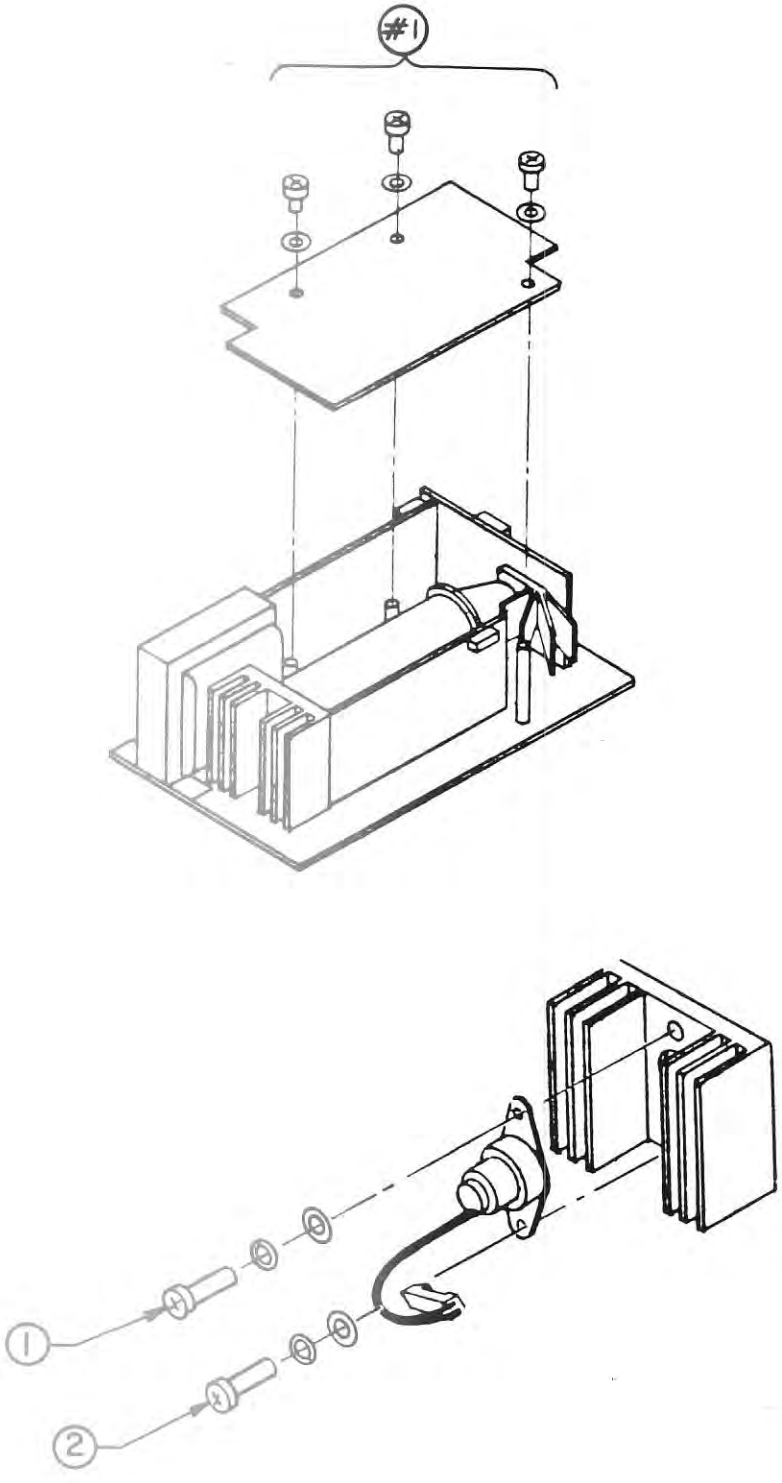
3. Steps To Follow

Figure 7-5 illustrates the following steps:

#1 Remove the Processor PCB as outlined above in paragraph 4.2

#2 On the Optical Assembly loosen the screws (1), (2) that attach the Motor to the Sample Cell

Figure 7-5 -- Source PCB Removal



4. Replacing Assemblies (cont'd)

5. Source PCB (cont'd)

#3 On the Source PCB, unplug the three power plugs to the the Source Power Connector (3), (4), (5). Note the following about the three pairs of wires:

Optical Assy. Origin	Source PCB Power Connection: Pin Locations (Bottom to top
1. Pair from upper slot on Filter Wheel Housing (3) (from the Filter Wheel Heater)	1. Pins 5 and 6
2. Pair from the Motor (4)	2. Pins 3 and 4
3. Pair from lower slot on Filter Wheel Housing (5) (from the Thermistor)	3. Pins 1 and 2

#4 On the Source PCB, remove the screw (6) holding the Source PCB to the half-inch post on the Base Plate

Note: Do not loosen the nut on the Source PCB that holds the Source Element to the Source PCB

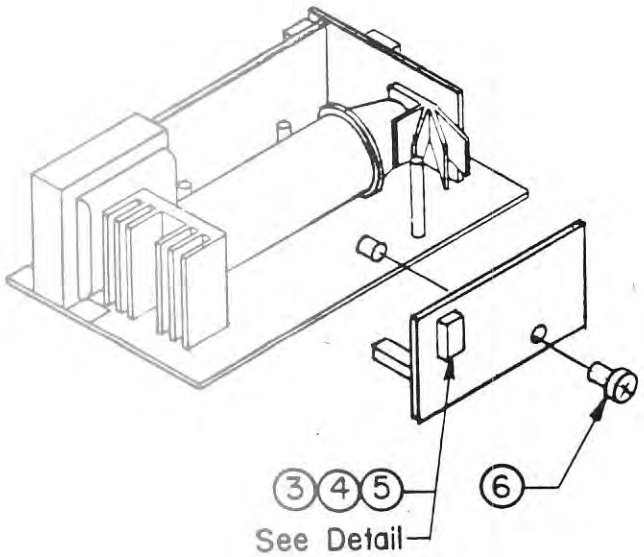
#5 Carefully pull the Source PCB away from the Sample Cell. Smoothly work the Source Element out of its slot in the Filter Wheel Housing (Loosen the Motor attachment screws as necessary to do so)

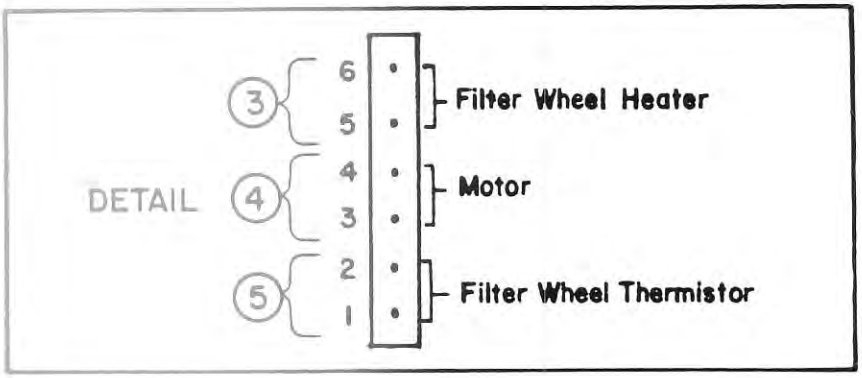
#6 Replace the Source PCB (assure that Source Element sits flush against Heat Sink)

#7 Tighten the Motor attachment screws

#8 Replace the Processor PCB (see paragraph 4.2)

Figure 7-6 -- Source PCB Removal





4. Replacing Assemblies (cont'd)

6. Optical Assembly

1. Equipment Needed

1. Screwdriver (Phillips Head)
2. Screwdriver (Slot)

2. Precautions

1. Disconnect Bench 200 from power and the parent system

3. Steps To Follow

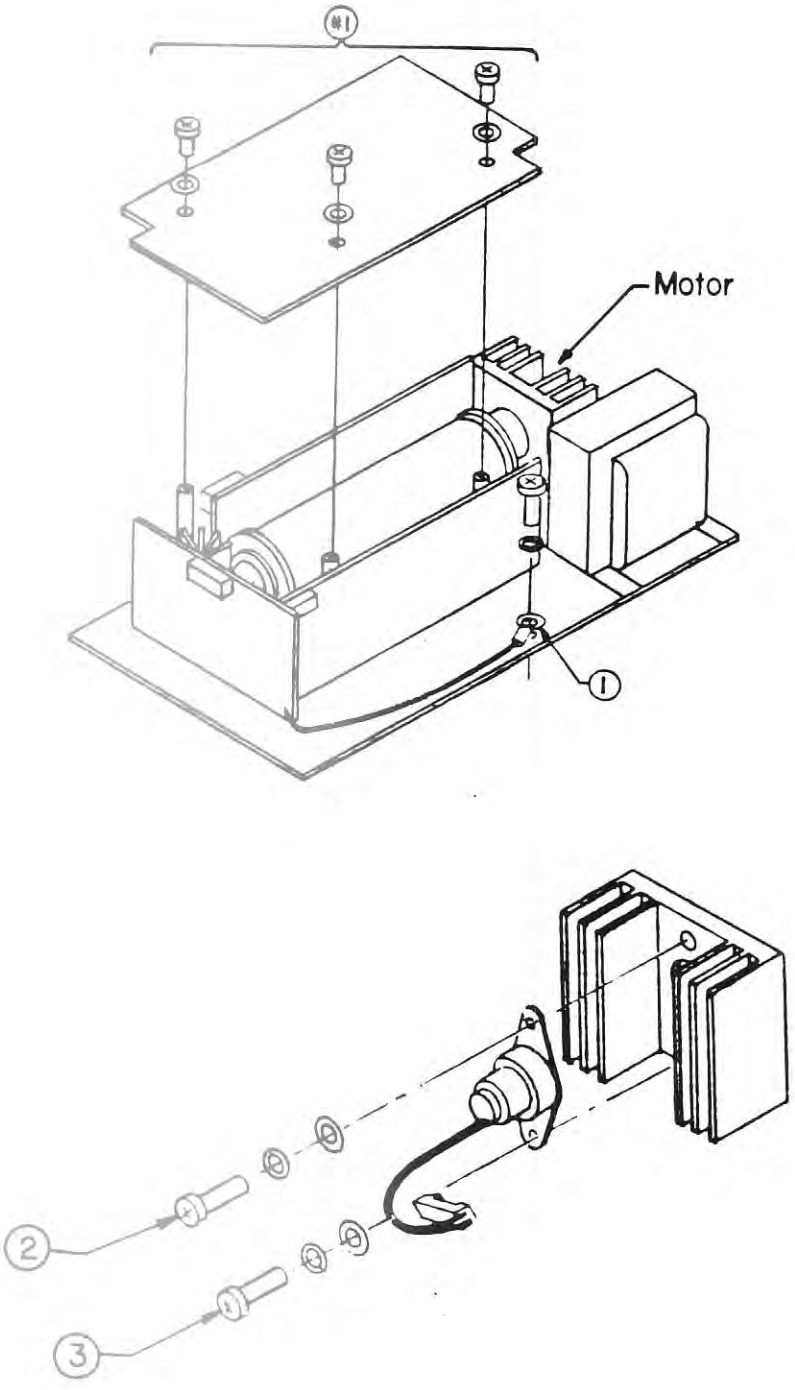
Figure 7-7 illustrates the following steps:

#1 Remove the Processor PCB as outlined above in paragraph 4.2

#2 On the Power Supply, remove the screw (1) to the grounding connector between the Power Supply and the Cooler-Preamp PCB

#3 On the Optical Assembly, slightly loosen the screws (2) (3) that attach the Motor to the Sample Cell

Figure 7-7 -- Optical Assembly Removal



4. Replacing Assemblies (cont'd)

6. Optical Assembly (cont'd)

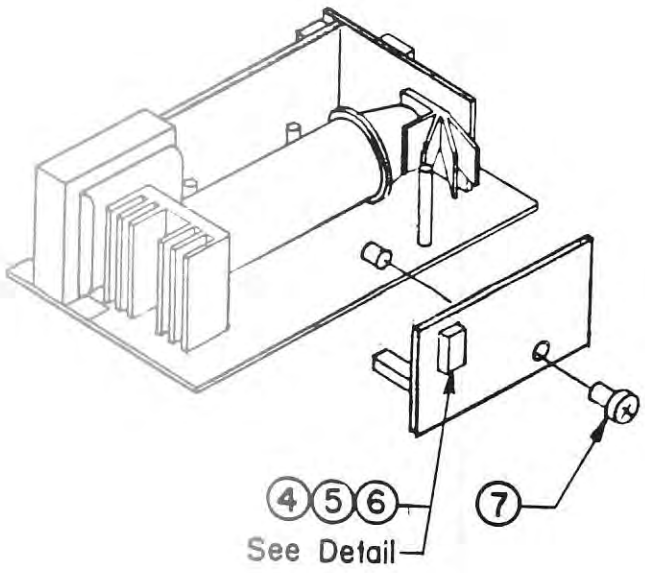
#4 On the Source PCB, unplug the three power plugs to the the Source Power Connector (4),(5),(6). Note the following about the three pairs of wires:

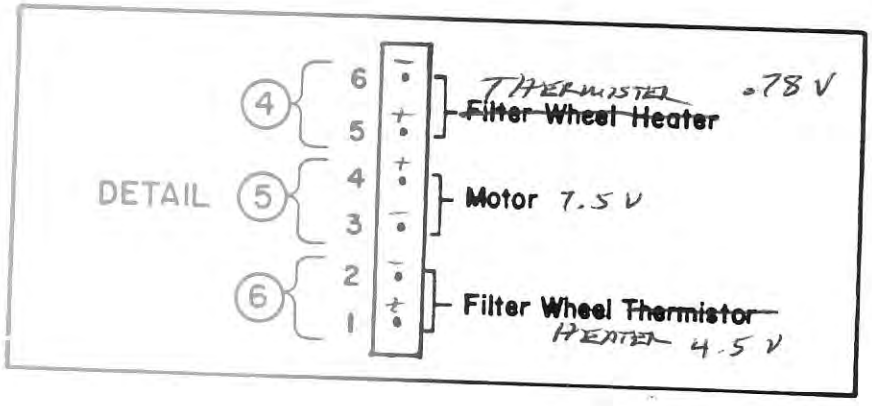
Optical Assy. Origin	Source PCB Power Connection: Pin Locations (Bottom to top
1. Pair from upper slot on Filter Wheel Housing (4) (from the Filter Wheel Heater)	1. Pins 5 and 6
2. Pair from the Motor (5)	2. Pins 3 and 4
3. Pair from lower slot on Filter Wheel Housing (6) (from the Thermistor)	3. Pins 1 and 2

#5 On the Source PCB, remove the screw (7) holding the Source PCB to the half-inch post on the Base Plate

Note: Do not loosen the nut on the Source PCB that holds the Source Element to the Source PCB

Figure 7-8 -- Optical Assembly Removal (Cont'd)





4. Replacing Assemblies (cont'd)

6. Optical Assembly (cont'd)

#6 Carefully pull the Source PCB away from the Sample Cell. Smoothly work the Source Element out of its slot in the Filter Wheel Housing (Loosen the Motor attachment screws as necessary to do so)

#7 Remove the four screws (8), (9), (10), (11) that attach the Optical Assembly to the Base Plate

#8 Replace the Optical Assembly

#9 On the Motor on the new Optical Assembly, slightly loosen the Motor attachment screws

#10 Reattach the Source Assembly

Note: See Step #4 for correct connections of the power wires from the Optical Assembly to the Source Assembly

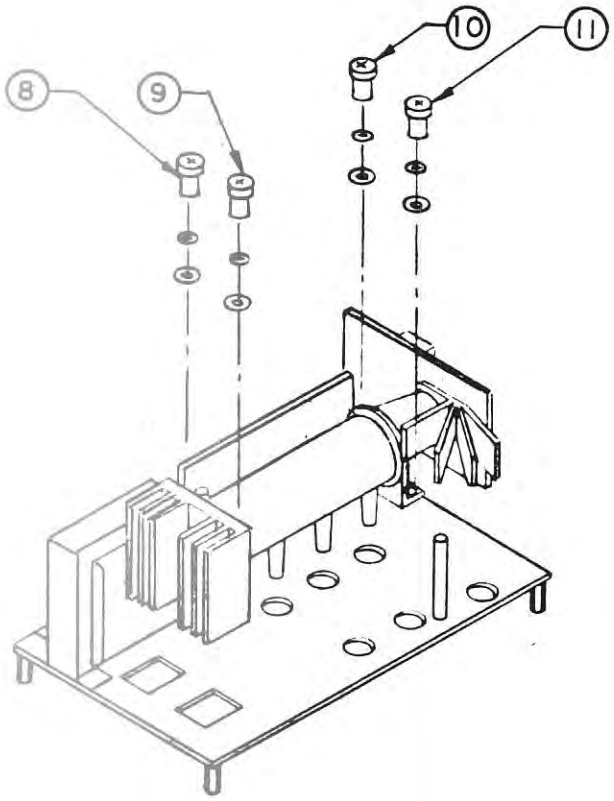
#11 Tighten the Motor attachment screws

#12 Reattach the Cooler-Preamp (with Detector-Collector)

#13 Reattach the grounding attachment screw of the Cooler-Preamp PCB to the Power Supply

#14 Reattach the the Processor PCB to the Power Supply PCB, Cooler-Preamp, and Source PCB (in that order)

Figure 7-9 -- Optical Assembly Removal (Cont'd)



5. Cleaning the Sample Cell Windows

1. Precautions

1. Disconnect Bench 200 from power and the parent system

2. Cleaning solvent hazards —

   flammability
   skin irritation
   inhalation injury
   (keep food and drink away from solvent)

2. Equipment

Screw driver (phillips head)
Cleaning swab (6-inch, Q-tip)
Cleaning cloth
Cleaner solvent (ethyl alcohol)

3. Steps To Follow

Figure 7-10 shows the parts concerned with the following steps:

#1. On the Processor PCB,
remove screws (1), (2), and (3)

#2. Detach the Processor PCB connector from the -

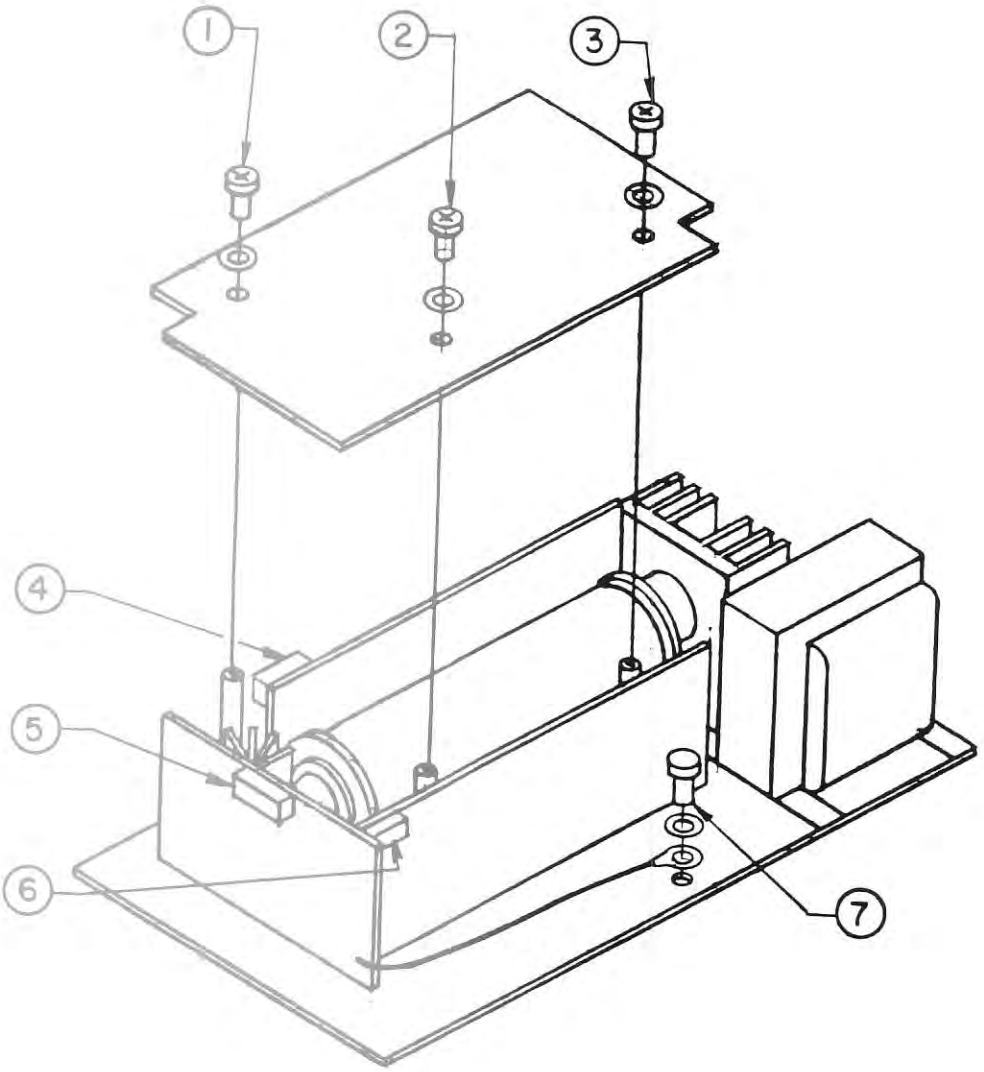
Source PCB connector (4)
Cooler-Preamp PCB connector (5)
Power Supply PCB connector (6)

#3. Place the unit on end with the motor and the transformer down

#4. On the Power Supply PCB,
remove the ground wire (7)

#5. Take a position looking down on the unit at the Cooler-Preamp PCB

Figure 7-10 — Cleaning Sample Cell Windows



5. Cleaning the Sample Cell Windows (cont'd)

3. Steps To Follow (cont'd)

#6 Through three access holes on the Cooler-Preamp PCB (1), (2), (3), note three screws attaching the Collector to the Sample Cell (4), (5), (6). Loosen those three screws attaching the Collector to the Sample Cell

Note: Do not remove the screws that attach the Preamp PCB to the Collector (7), (8), (9)

#7 Lift of the Cooler-Preamp PCB (with Collector) from the Sample Cell

Note: As you lift the Cooler-Preamp that the Sample Cell Exit (Mica) Window and its O-ring may stick to the Collector

#8 Remove the Mica Window and O-ring from the Sample Cell (or Collector). Note its coloration and condition for water spots. Set aside for cleaning

#9 Apply solvent to the Q-tip swab and apply to the Sapphire Window at the bottom of the Sample Cell. Use a minimum of three swabs with three separate applications

Note: If Mica the window has severe scratching or cracking, replace it.

#10 Clean the Exit (Mica) Window; wipe off the O-ring

Note: Do not attempt to clean the inner surface of the Sample Cell

#11 Reattach the Optical Assembly and Cooler-Preamp PCB as follows:

1. Place O-ring in the sill of the Sample Cell exit hole

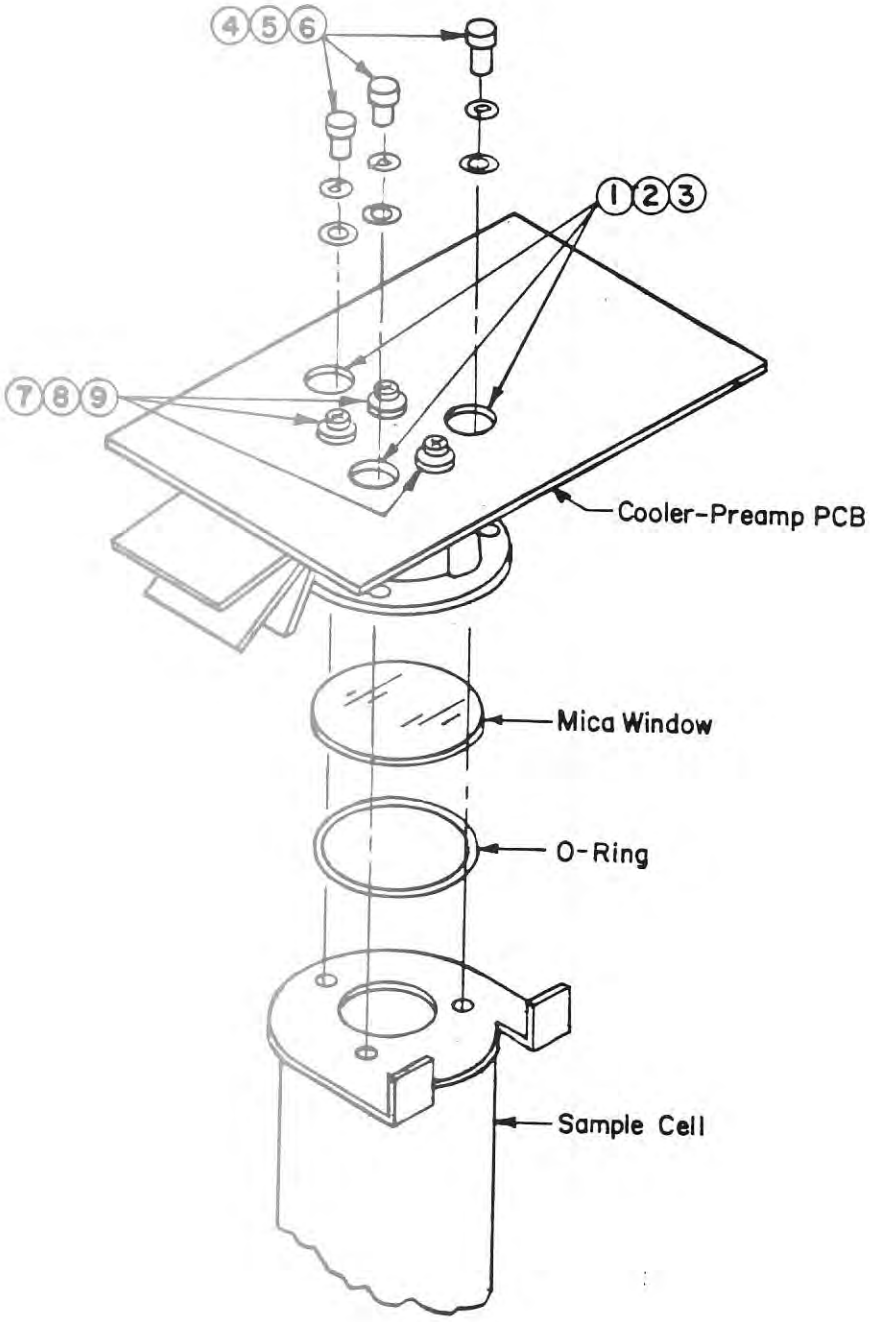
Note: Use no grease on the O-ring

2. Place Exit Window in place over the screw holes

3. Place Cooler-Preamp PCB so that Collector screw holes fit over the Sample Cell screw holes

4. Tighten the screws attaching Collector to the Sample Cell

Figure 7-11 — Cleaning Sample Cell Windows (Cont'd)



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5. Cleaning the Sample Cell Windows (cont'd)

#12 Reattach the Processor PCB connectors to the connectors of the other assemblies. Reattach in the following order:

1. Source PCB
2. Cooler-Preamp PCB
3. Power Supply PCB

#13 Reattach the Processor PCB to the Base Plate

#14 Recalibrate the unit according to Chapter 6 (Testing Procedures)

6. Replacing the Motor

1. Equipment Needed

1. Screwdriver (Phillips Head)
2. Screwdriver (Slot)

2. Precautions

1. Disconnect Bench 200 from power and the parent system

3. Steps To Follow

Replacing the Motor involves removing the Processor PCB, the Source PCB, installing a new Motor, and then reassembling the unit.

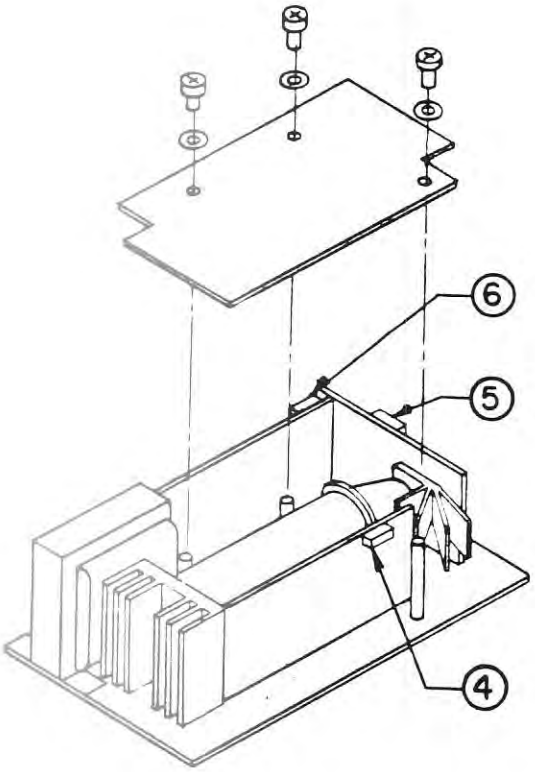
Figure 7-12 shows the parts described in the following steps:

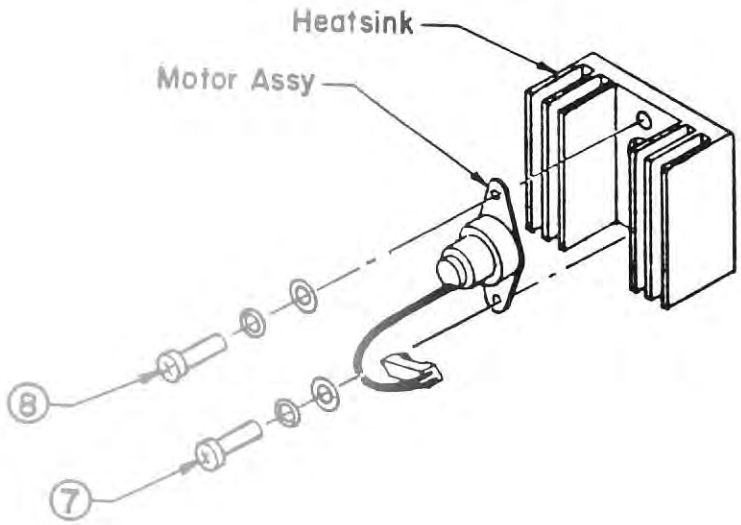
#1 On the Processor PCB, remove screws (1), (2), and (3)

#2 Detach the Processor PCB from its connectors to the Source PCB (4), the Cooler-Preamp (5), and the Power Supply PCB (6), in that order.

#3 On the Optical Assembly, slightly loosen the screws (7) (8) that attach the Motor to the Sample Cell

Figure 7-12 -- Replacing the Motor





6. Replacing the Motor (cont'd)

3. Steps To Follow

#4 On the Source PCB, unplug the three power plugs to the the Source Power Connector (1),(2),(3). Note the following about the three pairs of wires:

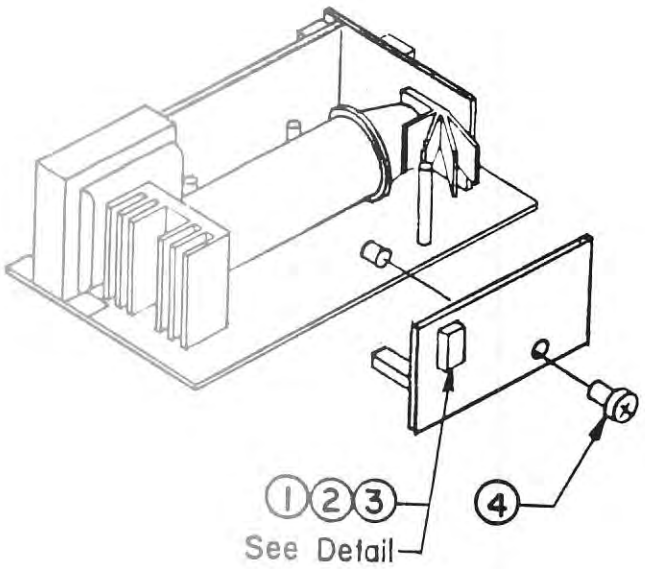
Optical Assy. Origin	Source PCB Power Connection: Pin Locations (Bottom to top
1. Pair from upper slot on Filter Wheel Housing (1) (from the Filter Wheel Heater)	1. Pins 5 and 6
2. Pair from the Motor (2)	2. Pins 3 and 4
3. Pair from lower slot on Filter Wheel Housing (3) (from the Thermistor)	3. Pins 1 and 2

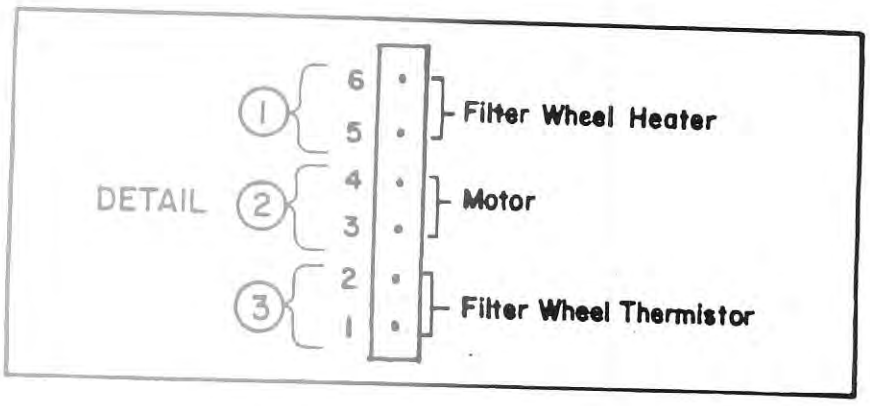
#5 On the Source PCB, remove the screw (4) holding the Source PCB to the half-inch post on the Base Plate

Note: Do not loosen the nut on the Source PCB that holds the Source Element to the Source PCB

#6 Carefully pull the Source PCB away from the Sample Cell. Smoothly work the Source Element out of its slot in the Filter Wheel Housing (Loosen the Motor attachment screws as necessary to do so)

Figure 7-13 -- Replacing the Motor (Cont'd)





6. Replacing the Motor (cont'd)

3. Steps To Follow

#7 As you carefully remove the Motor, hold the Insulator Assembly and the Filter Wheel Assembly in place in the Sample Cell. (See Figure 7-14)

#8 Take the Insulator Assembly and the Filter Wheel from the Filter Wheel Assembly Housing

#9 Note the position of the Thermister Bead on the Insulator Assembly. It should not touch the surface of the Insulator Assembly

#10 Set the Insulator Assembly and the Filter Wheel Assembly aside

#11 Place the replacement Motor in the Motor Heatsink inset so the power lines are to the right as you look from the Motor to the Sample Cell

#12 Place the Insulator Assembly in the Motor Heatsink inset. The Thermistor Bead should not touch the Insulator Assembly surface

#13 Insert the Filter Wheel shaft through the hole in the Insulator Assembly and over the Motor drive shaft. Press down so that the Filter Wheel shaft fully seated on the Motor shaft.

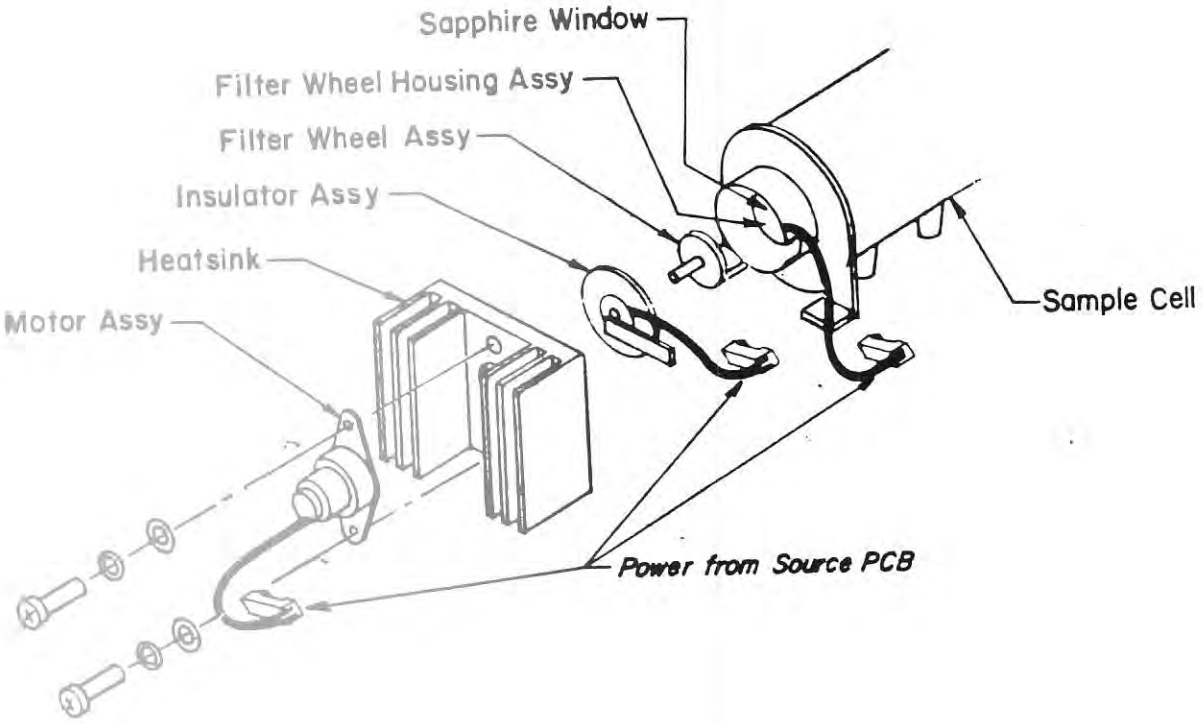
#14 Make sure the Thermistor power wires are in their slot on Insulator Assembly

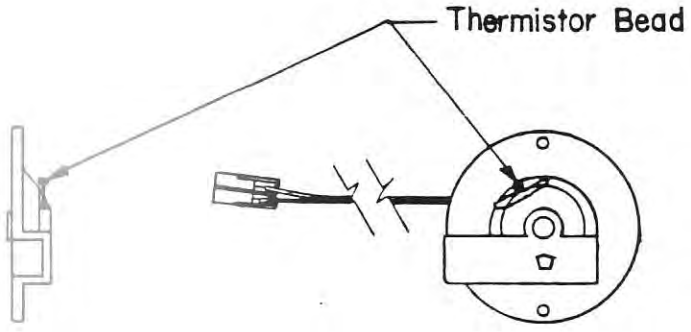
#15 Place this this entire assembly so that the Filter Wheel Assembly and the Insulator fit inside the Filter Wheel Housing.

#16 Make sure the Thermistor power wires go through the upper slot on the Filter Wheel Housing and that the Filter Wheel Heater power wires go through the lower slot on the Filter Wheel Housing

#17 Screw in the Motor attachment screws loosely

Figure 7-14 -- Replacing the Motor (Cont'd)





Insulator Assy.

6. Replacing the Motor (cont'd)

3. Steps To Follow (cont'd)

#18. Reattach the Source PCB (see step #4 for corrector power connections)

Note: Make sure that the Source Element is flush with the Motor Heatsink

#19 Tighten the Motor attachment screws just enough to flatten the lock washers

#20 Reattach the Processor PCB connectors to the connectors of the other assemblies. Reattach in the following order:

1. Source PCB
2. Cooler-Preamp PCB
3. Power Supply PCB

#21 Reattach the Processor PCB to the Base Plate

#22 Recalibrate the unit according to Chapter 6 (Testing Procedures)

7. Troubleshooting

The following table list commons symptoms, cause, and likely remedy for defective operations of the Bench 200:

Trouble	Cause	Diagnosis
1. Power Supply voltage out of limits (+/- 6.5V, +/- 15V)	1. Power Supply faulty 2. Processor short circucity 3. Cooler-Preamp short circuit 4. Source Assembly short circuit 5. Optical Assembly short circuit	1. Disconnect Power Supply: if failure continues, replace Power Supply If Power Supply checks OK in No.1: separately reconnect the -- 2. Cooler-Preamp 3. Source Assembly 4.1 Filter Wheel Thermistor 4.2 Filter Wheel Heater 4.3 Filter Wheel Motor
2. Filter Heater voltage out of limits (acceptable range 0 to 0.7 volts)		
3. Source Element voltage out of limit (acceptable range 7.8V +/-0.1V)		
4. Motor Speed out of limits (10.3 to 10.8 milliseconds) at DLTP...)	1. Power Supply faulty 2. Processor PCB faulty 3. Source Assembly faulty 4. Optical Assembly faulty	1. Set Source SW1 to OFF (Down or Pins 2-3): 2. If Motor RPM then runs in limits, the fault may be either the Motor Speed Servo (Source PCB) caused by Processor or the Detector (Cooler-Preamp) 4. If the Motor is still out of limits, the fault may be in the Optical Assembly: Check connections between Optical Assembly and Source (pin connections) __ Filter Wheel Thermistor (1-2) Motor (3-4) Filter Wheel Heater (5-6)

7. Troubleshooting (cont'd)

Trouble	Cause	Diagnosis
5. Preamp Signal (TP1) out of limits (280-300mV) with zero gas	1. Recalibration needed 2. Source Element faulty 3. Cooler-Preamp PCB faulty	
6. Preamp Signal (TP1) out of limits (280mV minimum) with a gas sample	1. Dirty Sample Cell Windows 2. Gas sample out of limits 3. Recalibration needed 4. Source PCB faulty	
7. Preamp Signal (TP1) missing with the Motor running	1. Source Element faulty 2. Optical Assembly faulty	
8. Hangup: reading won't return to zero	End-user putting the gas pickup too close to water Sample Cell and Exit Window are dirty	1. Clean Exit Window 2. Replace Sample Cell
9. Exit Window has multi-colored grime	End-user is sampling diesel emissions	1. Clean Exit Window 2. Replace Sample Cell 3. Request end-user limit testing to gasoline engines
10. Unable to calibrate Cooler-Preamp Signal to 300mV	Dirty Exit Window	1. Clean Exit Window 2. Replace Sample Cell
11. Motor Voltage out of range	Defective Motor	1. Replace Motor
12. Readings drift continuously	Source Element is not flush with Motor Heat Sink; Source Element is out of temperature range	1. Reposition Source Element 2. Replace Source PCB Assembly

8. Repair

Call Customer Service for an RMA (return material authorization) number. All products returned to Andros should have an RMA number.

Andros Customer Service Manager
Andros Analyzers, Inc.
2332 Fourth Street
Berkeley, CA 94710
415/849-1377

1. Repair Under Warranty

Andros will completely test, repair, updated, and recalibrated to factory standards.

2. Repair out of Warranty

Andros has a full-service repair department. Its repairs carry at least a 30-day warranty. This basic warranty can be extended. Cost of repairs is figured in two way. It may be either --

1. Standard Repair: costs at time and materials

2. Fixed-Fee Repair: major subassemblies are replaced at the cost of about 1.4 times spare parts list price.

9. Factory-rebuilt Units

Andros can rebuild your current unit completely. Rebuilding includes replacing defective parts and bringing units up to the latest revision level.

Chapter 8 - Parts Ordering

1. Parts Identification 8-3

2. Ordering by Maintenance Level 8-3

   1. Maintenance Level 1 8-3
   2. Maintenance Level 2 8-5
   3. Maintenance Level 3 8-5

3. Placing Parts Orders 8-5

4. Parts Order Checklist 8-6

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1. Parts Identification

Each unit has a unit identification serial number on the upper surface of the Base Plate at the corner of the Power Supply and the Cooler-Preamp PCBs.

Figure 8-1 is an example of such a unit identification label. On the label are the —

1. Model Number — 216B or 256B
2. Part Number — 451216-XXX or 451256-XXX
3. Revision Level — Rev. XX
4. Serial Number — XXXXX

2. Ordering by Maintenance Level

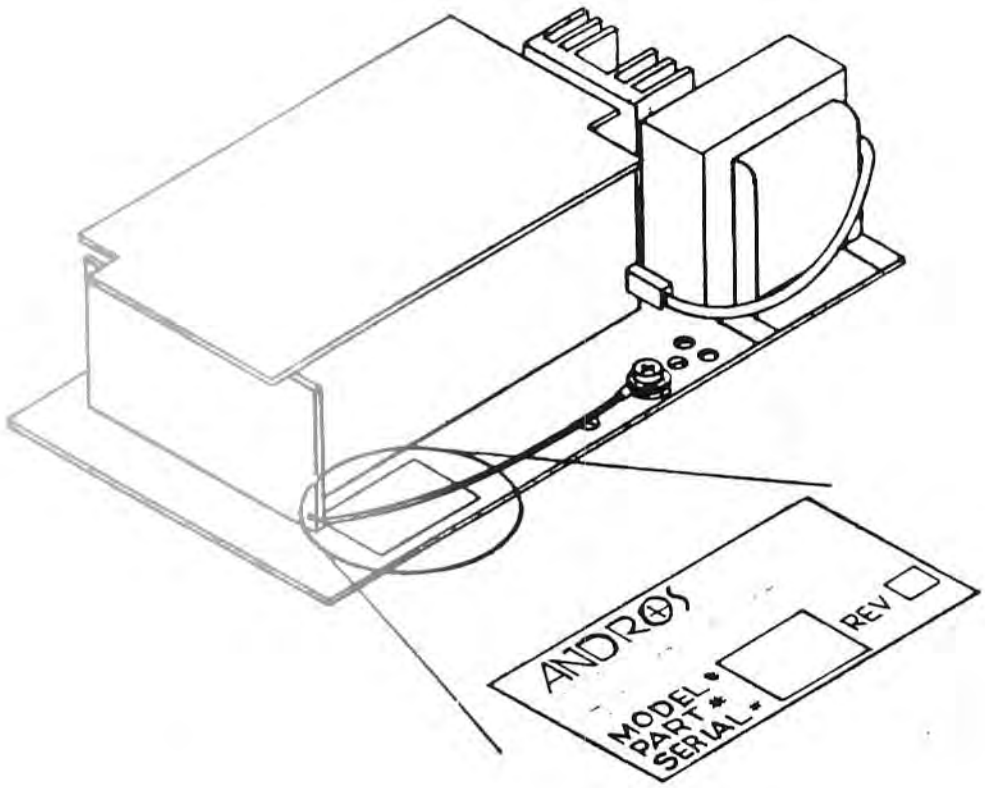
Replaceable parts can be ordered by OEMs according to their Maintenance Levels.

1. Maintenance Level 1

Replaceable parts (and their part numbers) for Maintenance Level 1 are the complete units:

1. Model 216B	1. 451216-0XX
2. Model 256B	2. 451256-0XX

Figure 8-1 -- Bench 200 Unit Identification Label



2. Ordering by Maintenance Level (cont'd)

2. Maintenance Level 2

Replaceable Parts and their part numbers are as follows:

1. Transformer and Base Plate Assembly	1. 451067-0XX
2. Power Supply Assembly	2. 451023-000
3. Source PCB Assembly	3. 451020-000
4. Optical Assembly	4. 451068-0XX
1. Motor	1. 450154-001
2. Sample Cell Mica Window	2. A391017-000
3. Mica Window O-ring	3. 453005-000
4. Cooler-Preamp PCB Subassembly	4. 451021-000
5. Processor PCB Assembly	5. 451046-000

3. Maintenance Level 3

OEMs at Maintenance Level 3 should notify Andros about those parts they wish to stock. Andros will provide OEMs with a parts list for their special requirements.

3. Placing Parts Orders

For ordering or information, phone or write to:

Customer Service Manager
Andros Analyzers, Inc.
2332 Fourth Street
Berkeley, CA 94710
~~(415)849-1377~~

510-849-5700
BOB BISHOP
for Bishop — Service Tech
x 5709

4. Parts Order Checklist

1. Company Name
2. Date
3. Purchase Order Number
4. Model Number — 216B or 256B
5. Serial Number — _____
6.

	Part Number	Part Name	Quantity	Price	Total
1.	_____	_____	____	$____	$____
2.	_____	_____	____	$____	$____
3.	_____	_____	____	$____	$____
4.	_____	_____	____	$____	$____
5.	_____	_____	____	$____	$____
6.	_____	_____	____	$____	$____
7.	_____	_____	____	$____	$____
8.	_____	_____	____	$____	$____
9.	_____	_____	____	$____	$____
10.	_____	_____	____	$____	$____

Chapter 9 - Administration and Training

1. Change Information 9-3

2. Copying the Manual 9-3

3. Warranty 9-3

4. Extended Warranty 9-3

5. Training 9-4

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1. Change Information

Information to cover corrections to this manual and technical changes to Bench 200 operations will be sent to OEMs in technical bulletins and Manual Change Notices.

Manual Change Notices will be numbered, will be complete page changes, and will indicate the material that has been changed.

OEM technicians who work on Bench 200 should make sure their manual has the latest Change Notice by comparing Appendix A (Manual Change Record) with OEM service management records.

2. Copying the Manual

The manual may by copied in whole or part for use by OEM employees and for use in the OEM manuals that will be used by end-users.

Written approval from Andros should be obtained by the OEM to copy this manual for other purposes.

3. Warranty

Andros warrants Bench 200 against defects in material and workmanship. The period of the warranty and related details are in the Andros purchase agreement.

4. Extended Warranty

The basic warranty may be extended by OEMs at any time at an agreed upon cost.

5. Training

Andros offers a Service Technician Bench 200 Operator Course for OEM service technicians. Training can be done at either Andros facilities or at a location chosen by the OEM.

The course takes two days. The course includes lectures and hands-on experience in —

1. Infrared Theory (Spectral, NDIR)
2. Basic Design Characteristics
3. Manufacture and Test Background
4. Review of Major Subassemblies
4. OEM Performance Testing
5. Troubleshooting
6. Parts Replacement Procedures
7. Recording Problems

Training may be arranged by contacting -

Customer Service Manager
Andros Analyzers, Inc.
2332 Fourth Street
Berkeley, CA 94710
~~415/849-1377~~
570-
849-5700

Chapter 10 - Quick Reference

1. Parts Order Checklist (Section 8.4) 10-3

2. Phone-in Assistance Checklist (Section 7.1.1) . 10-5

3. Abbreviated Test Procedures (Section 6.4) . . . 10-7

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1. Parts Order Checklist (Section 8.4)

1. Company Name
2. Date
3. Purchase Order Number
4. Model Number — 216B or 256B
5. Serial Number — _____
6.

	Part Number	Part Name	Quantity	Price	Total
1.	_____	_____	____	$____	$____
2.	_____	_____	____	$____	$____
3.	_____	_____	____	$____	$____
4.	_____	_____	____	$____	$____
5.	_____	_____	____	$____	$____
6.	_____	_____	____	$____	$____
7.	_____	_____	____	$____	$____
8.	_____	_____	____	$____	$____
9.	_____	_____	____	$____	$____
10.	_____	_____	____	$____	$____

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2. Phone-in Assistance Checklist (Section 7.1.1)

Phone-in Assistance Checklist

1. Company _____
2. Date _____
3. Call Number _____
4. Model/Serial No. _____
5. Date Bought _____
6. End-user operations _____

_____

7. Performance Check Defects

Check Item	Reading
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
8. _____	_____

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3. Abbreviated Test Procedures (Section 6.4)

Abbreviated Test Procedures are excerpted from the Summary Test Procedures. Paragraph numbers are the same.*

(To be done after physical inspection and 10 minute warmup)

Proc. No.	PCB to be Checked	Function To Be Checked	Item Checked	DMM/ CRO	Pots Adjust.	DMM/CRO Reading, Range, Remarks
1.	—					Setup for Test Procedures
2.1	Processor	Power Supply	A1J4	DMM	—	Read voltages at pins 2, 3, 10, 11
4.3	Processor	AGC Voltage	TP4	DMM	—	Read:+2.5 to 3.1V
5.1	Processor	Zero Adj: CO2	TP5	DMM	Int.Card: Pot R3	Range: set each equal to or less than -2.0 V; set each equal to or greater than +2.0 V Set each at 0.0 V +/-0.05V
5.2	Processor	Zero Adj: HC	TP6	DMM	Pot R1	
5.3	Processor	Zero Adj: CO	TP7	DMM	Pot R2	
	(Int. Card: offset TP5/6/7 about +/-100mV using zero adjust Pots R3/1/2)					
5.5	Processor	Gas Span: CO2	TP5	DMM	Int.Card Pot R8	Check adjustability from nominal voltage; then set at nominal voltage for each gas
5.6	Processor	Gas Span: HC	TP6	DMM	Pot R6	
5.7	Processor	Gas Span: CO	TP7	DMM	Pot R7	
5.10	Processor	Elec.Cal: CO2	TP5	DMM	Int.Card Pot R11	Check range less than 8.5 V
5.11	Processor	Elec.Cal: HC	TP6	DMM	Pot R9	Check range greater than 11.5 V
5.12	Processor	Elec.Cal: CO	TP7	DMM	Pot R10	Set each Pot to +10V +/-0.05 V

Note:(*) You should use the complete test procedures when troubleshooting (Chapter 7) and when you want to be certain of direct measurements for all key components in the system.

The Abbreviated Test Procedures include key parts of the test procedures. If a unit meets the test requirements of the Abbreviated Test Procedures, that unit will meet the other test standards for the system. This short test thus may be used for a quick check of an operating unit.

Appendix Summary

A. Manual Change Record

B. Equipment Specificiations

C. Calibration Gas Specifications

D. Gas Voltage Output Tables

E. Diagrams, Schematics, Tables

F. User Comment Sheet

G. Glossary

Appendix A - Manual Change Record

Change Number	Date	Chapters Changed	Remarks/Change Purpose
_____	__/__/__	_____	_____
_____	__/__/__	_____	_____
_____	__/__/__	_____	_____
_____	__/__/__	_____	_____
_____	__/__/__	_____	_____
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_____	__/__/__	_____	_____
_____	__/__/__	_____	_____
_____	__/__/__	_____	_____

Appendix B - Equipment Specifications

Model 256B Specifications*
Model 216B Specifications except for CO2

Measureable Gases	HC	Hydrocarbon (n-Hexane)
	CO	Carbon Monoxide
	CO2	Carbon Dioxide
Range/Concentration Measureable	HC	0 - 2,000 ppm
	CO	0 - 10%
	CO2	0 - 20%
Output (Nonlinear DC Signal)	Zero	0 - +/-2 VDC Adjustable
	Span	10 VDC ful scale per standard curves (see Appendix D)
Accuracy		Per standard curves (see Appendix D)
Repeatability	HC	+/- 2% full scale
	CO	+/- 2% full scale
	CO2	+/- 3% full scale
Drift (Over 4 hours @ 70 to 74 deg.F)	HC	+/- 8 ppm
	CO	+/- 0.04%
	CO2	+/- 0.05%
Warmup/Stabilize Period		Less than 10 minutes to full accuracy
Response Time (Optics and electronics at 15 liters per minute)		5 seconds (0 - 90% of reading)
HC Hangup (Optics and electronics at 15 liters per minute)		1 to 2 seconds (10 - 90%, 90 - 3% of reading)

Note:(*) Specifications verified using California Bureau of Automotive Repair 1980 Standards.

Interference	Less than +/- 10 ppm HC, low scale, when exposed to: HC a. 15% CO2 in air b. 3% H2O vapor in air c. 3,000 ppm NO in N2 d. 10% O2 in N2 e. 10% CO in N2 Less than +/- 0.05% CO, low scale, when exposed to: CO a. 15% CO2 in air b. 3% H2O vapor in air c. 3,000 ppm NO in NO2 d. 10% O2 in N2 e. 1,600 ppm HC in N2 Less than +/- 0.2% CO2 when exposed to: CO2 a. 10% CO in N2 b. 3% H2O vapor in air c. 3,000 ppm NO in N2 d. 10% O2 in N2 e. 1,600 ppm HC in N2
Noise (peak-to-peak)	HC Less than 4 ppm, zero scale CO Less than 0.02%, zero scale CO2 Less than 0.02%, zero scale
Optical Correction Factor (Propane Equivalency Factor)	0.40 - 0.64 (factory calibrated)
Internal Calibration (An electronic calibration check of output voltage without using calibration gas)	Provides an output voltage that can be matched to a gas concentration. Accuracy is maintained within +/-4% full scale over the temperature range 55 to 100 deg.F
Internal Calibration Control	External switch closure to signal ground
Adjustments	Zero, span, and internal calibration for each gas
Power	115 VAC +/- 10%, 60 Hz, 60 watts (max)
Operating Temperature	35 to 120 degrees F
Operating Humidity	0 - 85% (noncondesing) throughout the operating temperature range

Zero Drift due to Ambient Temperature Change	HC +/- 0.8 ppm/deg.F CO +/- 0.004%/deg.F, zero gas CO2 +/- 0.01%/deg.F, zero gas
Span Drift due to Ambient Temperature Change (after zero and internal span adjustment)	Less than +/- 3% over the range of 55 to 100 degrees F
Sampling Requirements	Filtered (50 micron or better) exhaust gas with no liquid carry-over or condesnation
Mechanical	Size: 5" x 7" x 10" max Weight: 6.5 pounds max
Cooling Requirements	a. Minimum of 250 ft/min of filtered air (approximately 3 mph) over Source, Detector, and Power Supply Heatsink areas b. Minimum clearance of 4 inches from top of unit for convection cooling
Preventive Maintenance	None required
Mean Time Between Failures (MTBF)	4,000 hours (estimated)
Mean Time To Repair (MTTR)	Less than 1/2 hour including calibration, with assembly replacement
Sample System Connection	2 inlets, 1 outlet, 1/4" ID hose
Electrical Interfaces	AC Power: 2 pin in-line connector, amp P/N 640426-2 or equivalent, also AC ground lug to chassis Signal: 26 pin connector, 3M P/N 3429-2002 or equivalent mating connector 3M P/N 3399-3000 Test: 16 pin DIP socket
Options	50/60 Hz and 220V operation
Interface Card (sometimes called Remote Adjustment Digital Interface Module, RADIM)	Configured for 2 or 3 gas channels (CO2 optional); used as a calibration aid

Appendix C - Calibration Gas Specifications

Parameter	N2*	CO*	HC*	CO2*	Propane*
Nominal Concentration +/- 5% TOL	99.99%	8% CO	1,600 ppm	13.5%	3,000 ppm
Total Hydrocarbon Analysis	Less than 6 ppm	Less than 6 ppm	N/A	Less than 6 ppm	N/A
Cylinder Pressure (PSI) As delivered	2,200 Max 2,090 Min	1,700 Max 1,600 Min	750 Max 710 Min	2,000 Max 1,900 Min	2,200 Max 2,090 Min
Flammability	Non- (1)	Non- (1)	Non- (1)	Non- (1)	Non- (1)
Toxicity	Non- (2)	Non- (2)	Non- (2)	Non- (2)	Non- (2)
Tolerance on Analysis	N/A	+/- 1%	+/- 1%	+/- 1%	+/- 1%
Trace CO	Less than 20 ppm	N/A	Less than 20 ppm	Less than 20 ppm	Less than 20 ppm
Trace H2O	Less than 6 ppm	N/A	N/A	N/A	N/A

Notes:(*) N2 gas is nitrogen/dry
CO gas is mixture of carbon monoxide/nitrogen
HC gas is mixture of n-hexane in nitrogen
CO2 gas is mixture of carbon dioxide/nitrogen
Propane gas is mixture of propane in nitrogen

(1) Limit of Flammability: the minimum and maximum limits of concentration in air or oxygen of a pure substance below and above which flame propagation does not occur upon contact with an ignition source

(2) Threshold Limit Value (TLV): the time-weighted average concentration of an airborn substance to which workers may be exposed for an eight-hour, five-day week without suffering toxic effects. TLVs are as follows: N2, N/A; HC, Propane, 1,000 ppm; CO, 500 ppm

Appendix D - Gas Voltage Output Tables

Table D-1 -- Gas Voltage Output: CO2

Table D-2 -- Gas Voltage Output: HC

Table D-3 -- Gas Voltage Output: CO

Table D-1 -- Gas Voltage Output: CO2

% CO2	OUTPUT VOLTS	% CO2	OUTPUT VOLTS	% CO2	OUTPUT VOLTS
4.5	3.783	8.0	5.708	11.5	7.197
4.6	3.846	8.1	5.756	11.6	7.236
4.7	3.908	8.2	5.803	11.7	7.274
4.8	3.970	8.3	5.850	11.8	7.312
4.9	4.032	8.4	5.896	11.9	7.350
5.0	4.093	8.5	5.942	12.0	7.388
5.1	4.153	8.6	5.988	12.1	7.426
5.2	4.213	8.7	6.034	12.2	7.464
5.3	4.273	8.8	6.079	12.3	7.501
5.4	4.332	8.9	6.124	12.4	7.539
5.5	4.390	9.0	6.168	12.5	7.576
5.6	4.448	9.1	6.212	12.6	7.613
5.7	4.506	9.2	6.256	12.7	7.650
5.8	4.563	9.3	6.300	12.8	7.687
5.9	4.619	9.4	6.343	12.9	7.724
6.0	4.676	9.5	6.386	13.0	7.761
6.1	4.731	9.6	6.429	13.1	7.798
6.2	4.786	9.7	6.471	13.2	7.834
6.3	4.841	9.8	6.514	13.3	7.871
6.4	4.896	9.9	6.556	13.4	7.907
6.5	4.949	10.0	6.597	13.5	7.943
6.6	5.003	10.1	6.639	13.6	7.979
6.7	5.056	10.2	6.680	13.7	8.015
6.8	5.108	10.3	6.721	13.8	8.051
6.9	5.161	10.4	6.762	13.9	8.087
7.0	5.212	10.5	6.802	14.0	8.123
7.1	5.264	10.6	6.842	14.1	8.158
7.2	5.315	10.7	6.883	14.2	8.194
7.3	5.365	10.8	6.923	14.3	8.229
7.4	5.416	10.9	6.962	14.4	8.265
7.5	5.465	11.0	7.002	14.5	8.300
7.6	5.515	11.1	7.041	14.6	8.335
7.7	5.564	11.2	7.080	14.7	8.370
7.8	5.612	11.3	7.120	14.8	8.404
7.9	5.660	11.4	7.158	14.9	8.439

Table D-2 -- Gas Voltage Output: HC

ppm HC	Output Volts	ppm HC	Output Volts	ppm HC	Output Volts
780	4.372	820	4.579	860	4.784
781	4.377	821	4.584	861	4.789
782	4.382	822	4.589	862	4.794
783	4.387	823	4.594	863	4.799
784	4.393	824	4.599	864	4.804
785	4.398	825	4.604	865	4.809
786	4.403	826	4.609	866	4.814
787	4.408	827	4.615	867	4.819
788	4.413	828	4.620	868	4.824
789	4.419	829	4.625	869	4.829
790	4.424	830	4.630	870	4.835
791	4.429	831	4.635	871	4.840
792	4.434	832	4.640	872	4.845
793	4.439	833	4.645	873	4.850
794	4.444	834	4.650	874	4.855
795	4.450	835	4.656	875	4.860
796	4.455	836	4.661	876	4.865
797	4.460	837	4.666	877	4.870
798	4.465	838	4.671	878	4.875
799	4.470	839	4.676	879	4.880
800	4.475	840	4.681	880	4.885
801	4.481	841	4.686	881	4.891
802	4.486	842	4.691	882	4.896
803	4.491	843	4.697	883	4.901
804	4.496	844	4.702	884	4.906
805	4.501	845	4.707	885	4.911
806	4.506	846	4.712	886	4.916
807	4.512	847	4.717	887	4.921
808	4.517	848	4.722	888	4.926
809	4.522	849	4.727	889	4.931
810	4.527	850	4.732	890	4.936
811	4.532	851	4.738	891	4.941
812	4.537	852	4.743	892	4.946
813	4.542	853	4.748	893	4.951
814	4.548	854	4.753	894	4.957
815	4.553	855	4.758	895	4.962
816	4.558	856	4.763	896	4.967
817	4.563	857	4.768	897	4.972
818	4.568	858	4.773	898	4.977
819	4.573	859	4.778	899	4.982
				900	4.987

Table D-3 -- Gas Voltage Output: CO

% CO	OUTPUT VOLTS
7.80	8.822
7.81	8.828
7.82	8.834
7.83	8.840
7.84	8.845
7.85	8.851
7.86	8.857
7.87	8.862
7.88	8.868
7.89	8.874
7.90	8.879
7.91	8.885
7.92	8.891
7.93	8.897
7.94	8.902
7.95	8.908
7.96	8.914
7.97	8.919
7.98	8.925
7.99	8.931
8.00	8.936
8.01	8.942
8.02	8.948
8.03	8.953
8.04	8.959
8.05	8.965
8.06	8.970
8.07	8.976
8.08	8.981
8.09	8.987
8.10	8.993
8.11	8.998
8.12	9.004
8.13	9.010
8.14	9.015
8.15	9.021
8.16	9.026
8.17	9.032
8.18	9.038
8.19	9.043
8.20	9.049

Appendix E - Diagrams, Schematics, Tables

Title	Type	Drawing No.
1. Cooler-Preamp PCB	Schematic	771021-000
2. Hydrocarbons	Table	N/A
3. Interconnection	Diagram	45256-001
4. Interface Card	Schematic	_____
5. Interface Connector Pinout Assignments	Table	N/A
6. Power Supply PCB	Schematic	771023-000
7. Processor PCB (046, Rev. E)	Schematic	771046-000 (Rev. E)
8. Processor PCB (046, Rev. D)	Schematic	771046-000 (Rev. D)
9. Processor PCB (036, Historical)	Schematic	771036-000
10. Source PCB	Schematic	771020-XXX
11. Test Connector Pinout Assignments	Table	N/A

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Hydrocarbons

1,3-butadiene
1-methyl-4-ethyl benzene
2,3-dimethyl pentane
2-butene
2-methyl-1-butane
2-methyl-2-butane

acetylene

benzene
butyl benzene

cyclopente

dodecane

ethane
ethyl benzene
ethylene

hexane

isoprene

methane
n-butane
n-pentane

pentane
propadiene
propyl benzene
propylene

toluene

xylene

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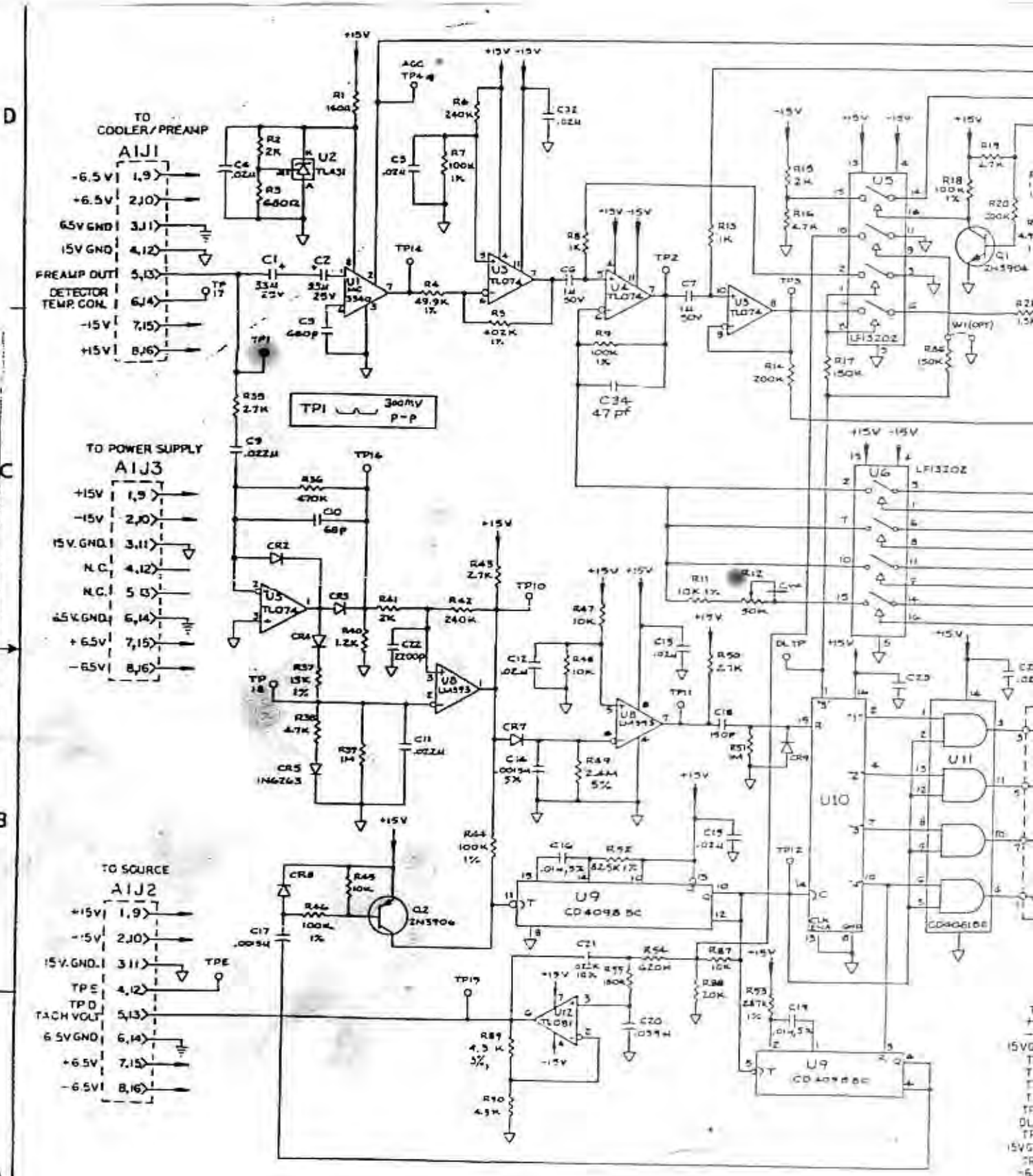

2. CR1 - CR4 & CR7 - CR11 ARE IN4148
ALL RESISTORS, 1/4W, 5% CARBON FILM.

NOTES: (UNLESS OTHERWISE SPECIFIED)

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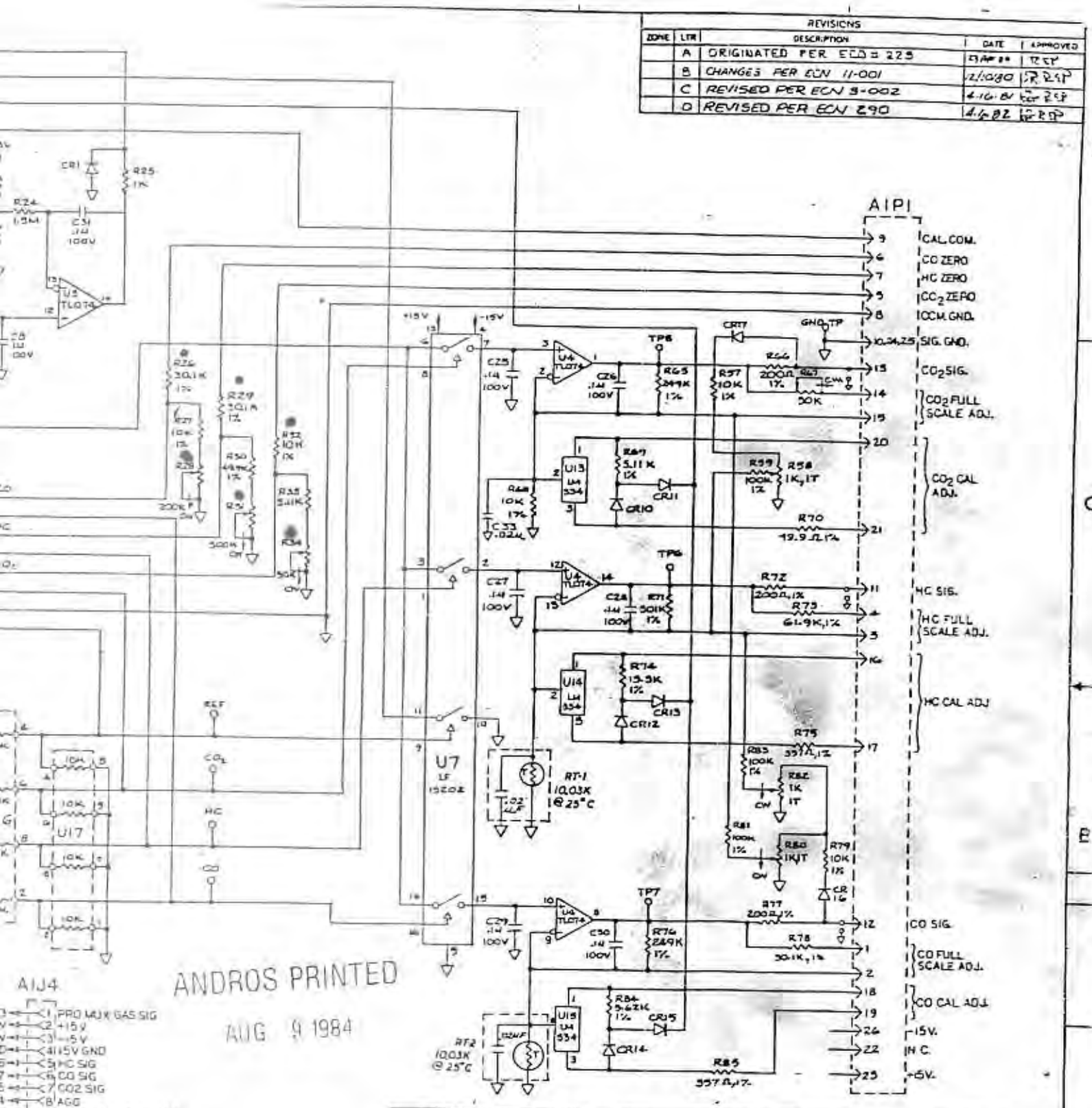
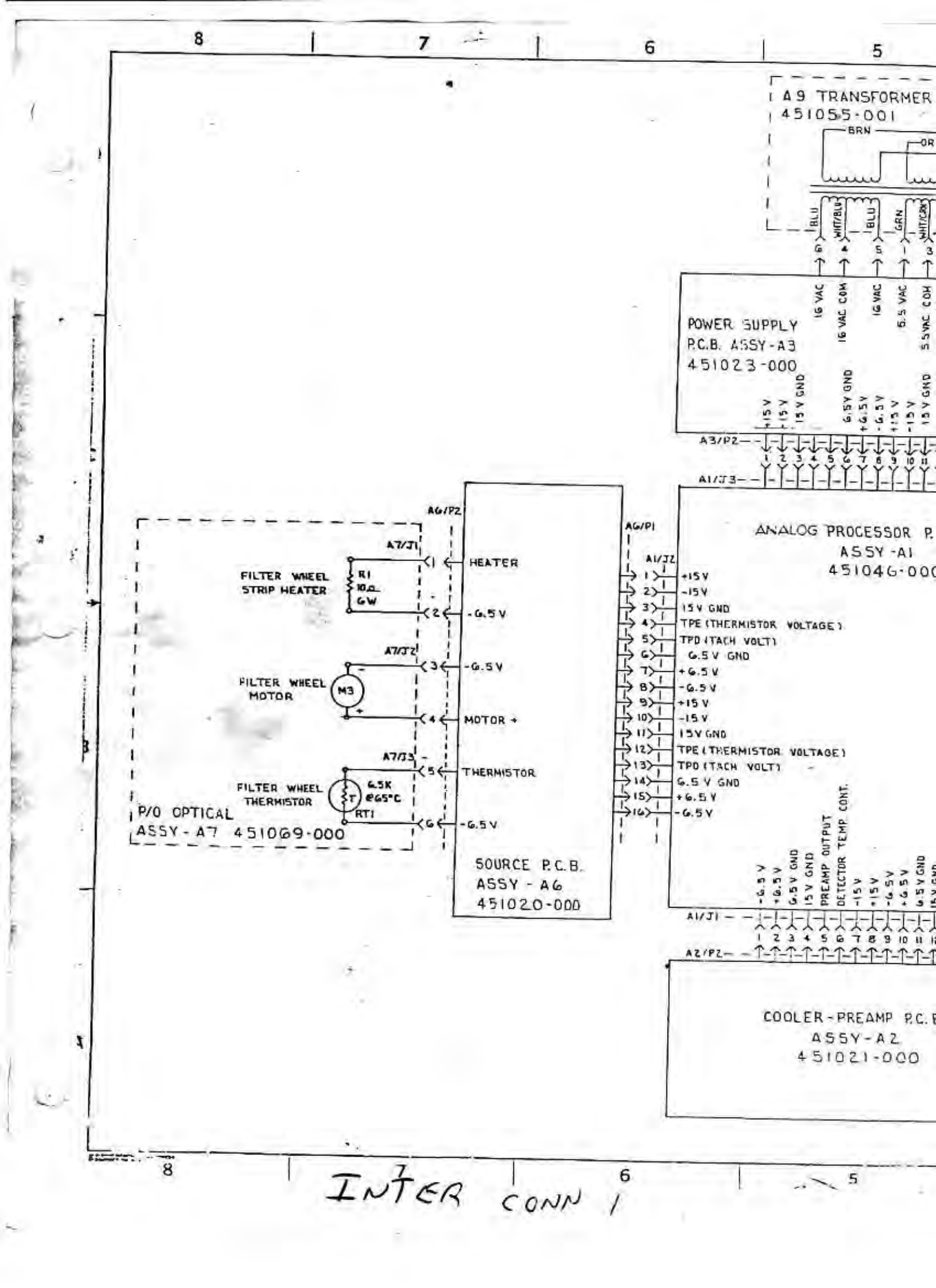
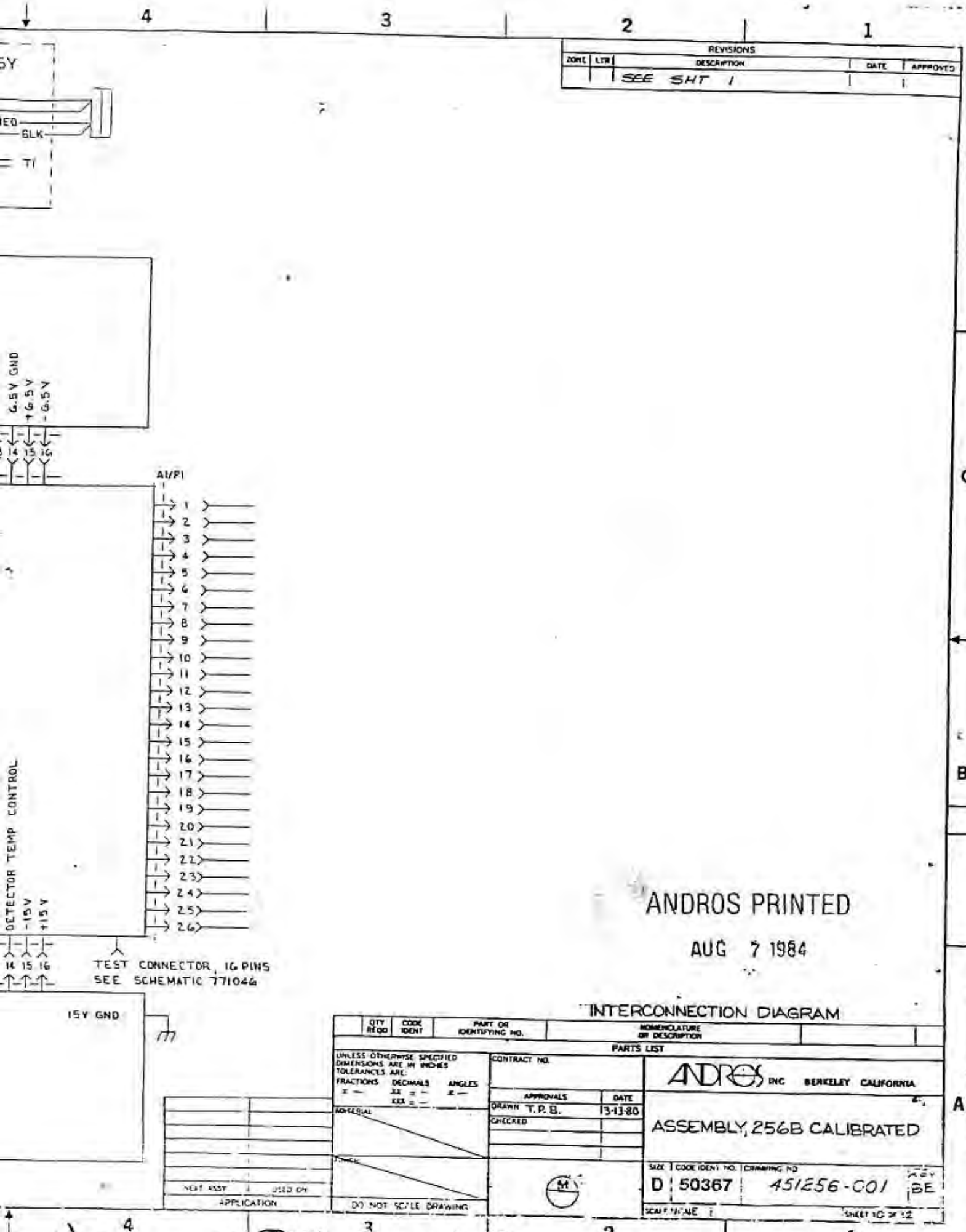
11/1/8

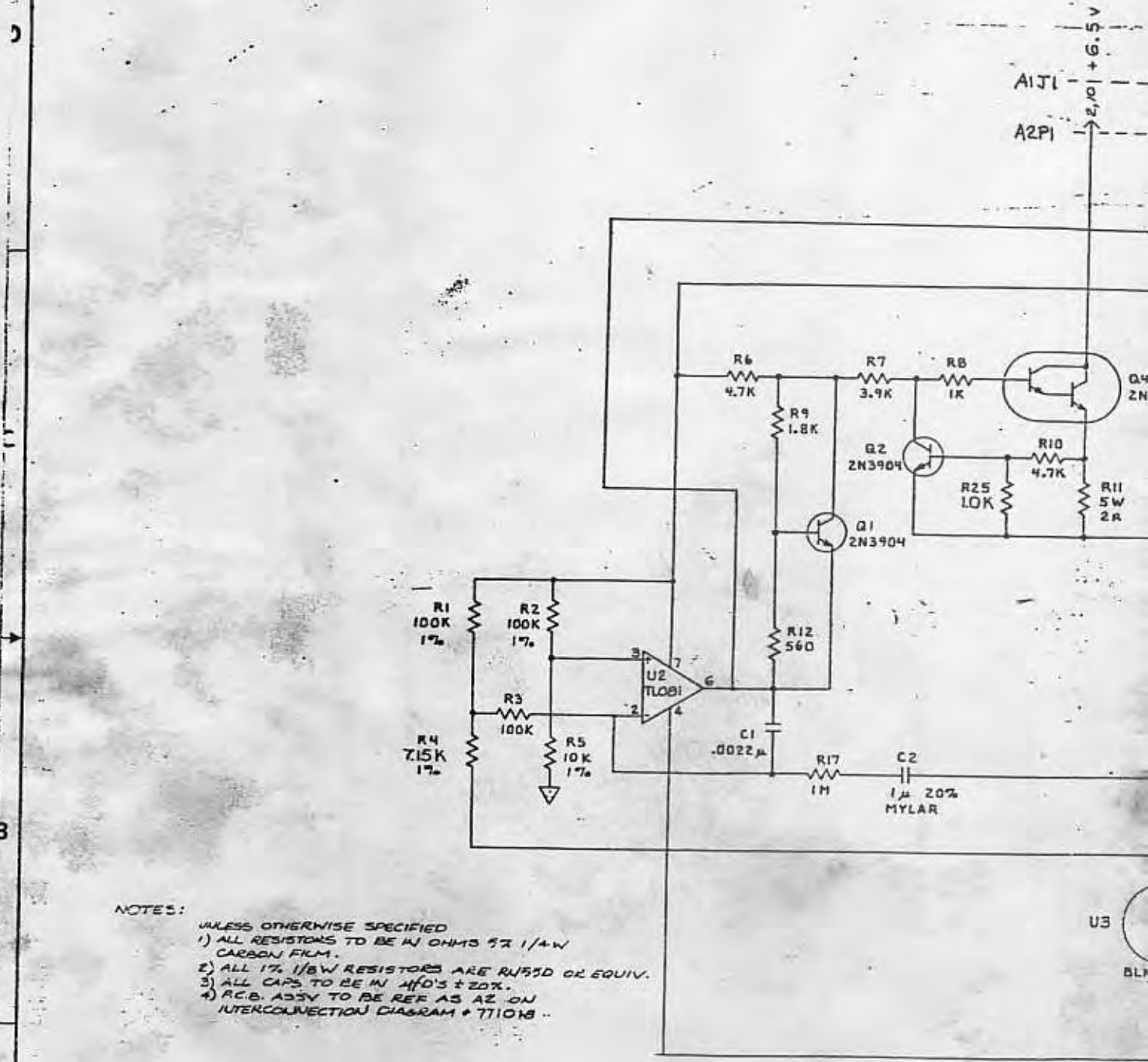
ANALOG


REVISIONS
ZONE | LTR | DESCRIPTION | DATE | APPROVED
A | ORIGINATED PER ECO # 225
B | CHANGES PER ECN 11-001
C | REVISED PER ECN 3-002
D | REVISED PER ECN 290
AIP1
CAL COM.
CO ZERO
HC ZERO
CO2 ZERO
COM. GND.
SIG. GND.
CO2 SIG.
CO2 FULL SCALE ADJ.
CO2 CAL ADJ.
HC SIG.
HC FULL SCALE ADJ.
HC CAL ADJ
CO SIG.
CO FULL SCALE ADJ.
CO CAL ADJ.
-15V.
N.C.
+5V.
U7
LF 13202
RT1 10.03K @ 25°C
RT2 10.03K @ 25°C
U17
AIJ4
1 PRO MUX GAS SIG
2 +15 V
3 -15 V
4 15V GND
5 HC SIG
6 CO SIG
7 CO2 SIG
8 AGC
9 SAMPLE PERIOD GEN.
10 SCOPE SYNC.
11 DETECTOR TEMP. CONT.
12 15 V GND
13 AGC AMP
14 -5 V
15 +5 V
16 FILTER WHEEL TEMP. CONT.
ANDROS PRINTED
AUG 9 1984
PARTS LIST
ANDROS INC BERKELEY CALIFORNIA
SCHEMATIC DIAGRAM
ANALOG PROCESSOR P.C.B.
SIZE D | CODE IDENT NO 50367 | DRAWING NO 77046-000
SCALE — | SHEET 1 OF 1
DO NOT SCALE DRAWING

2 ANALOG


8
7
6
5
A9 TRANSFORMER
451055-001
BRN
OR
BLU
WHT/BLU
BLU
GRN
WHT/GRN
16 VAC
16 VAC COM
16 VAC
6.5 VAC
6.5 VAC COM
POWER SUPPLY
P.C.B. ASSY-A3
451023-000
+15 V
-15 V
15 V GND
6.5 V GND
+6.5 V
-6.5 V
+15 V
-15 V
15 V GND
A3/P2
A1/J3
A6/P2
A6/P1
A7/J1
HEATER
FILTER WHEEL
STRIP HEATER
R1
10Ω
6W
-6.5 V
A7/J2
-6.5 V
FILTER WHEEL
MOTOR
M3
MOTOR +
A7/J3
THERMISTOR
FILTER WHEEL
THERMISTOR
6.5K
@65°C
RT1
-6.5 V
P/O OPTICAL
ASSY-A7 451069-000
SOURCE P.C.B.
ASSY-A6
451020-000
A1/J2
+15 V
-15 V
15 V GND
TPE (THERMISTOR VOLTAGE)
TPD (TACH VOLT)
6.5 V GND
+6.5 V
-6.5 V
+15 V
-15 V
15 V GND
TPE (THERMISTOR VOLTAGE)
TPD (TACH VOLT)
6.5 V GND
+6.5 V
-6.5 V
ANALOG PROCESSOR P.
ASSY-A1
451046-000
A1/J1
-6.5 V
+6.5 V
6.5 V GND
15 V GND
PREAMP OUTPUT
DETECTOR TEMP CONT.
-15 V
+15 V
-6.5 V
+6.5 V
6.5 V GND
A2/P2
COOLER-PREAMP P.C.
ASSY-A2
451021-000
8
7
6
5
INTER CONN 1


4
3
2
1
REVISIONS
ZONE | LTR | DESCRIPTION | DATE | APPROVED
SEE SHT 1
D
C
B
A
BLK
TI
+6.5V GND
+6.5V
-6.5V
A1/P1
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
DETECTOR TEMP CONTROL
-15V
+15V
14 15 16
TEST CONNECTOR, 16 PINS
SEE SCHEMATIC 771046
15V GND
ANDROS PRINTED
AUG 7 1984
INTERCONNECTION DIAGRAM
QTY REQD | CODE IDENT | PART OR IDENTIFYING NO. | NOMENCLATURE OR DESCRIPTION
PARTS LIST
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
x — xx = — x —
xxx = —
MATERIAL
FINISH
NEXT ASSY USED ON
APPLICATION
DO NOT SCALE DRAWING
CONTRACT NO.
APPROVALS | DATE
DRAWN T.P.B. | 3-13-80
CHECKED
ANDROS INC BERKELEY CALIFORNIA
ASSEMBLY, 256B CALIBRATED
SIZE | CODE IDENT NO. | DRAWING NO | REV
D | 50367 | 451256-C01 | BE
SCALE NONE
SHEET 10 OF 12
INTER-CONN

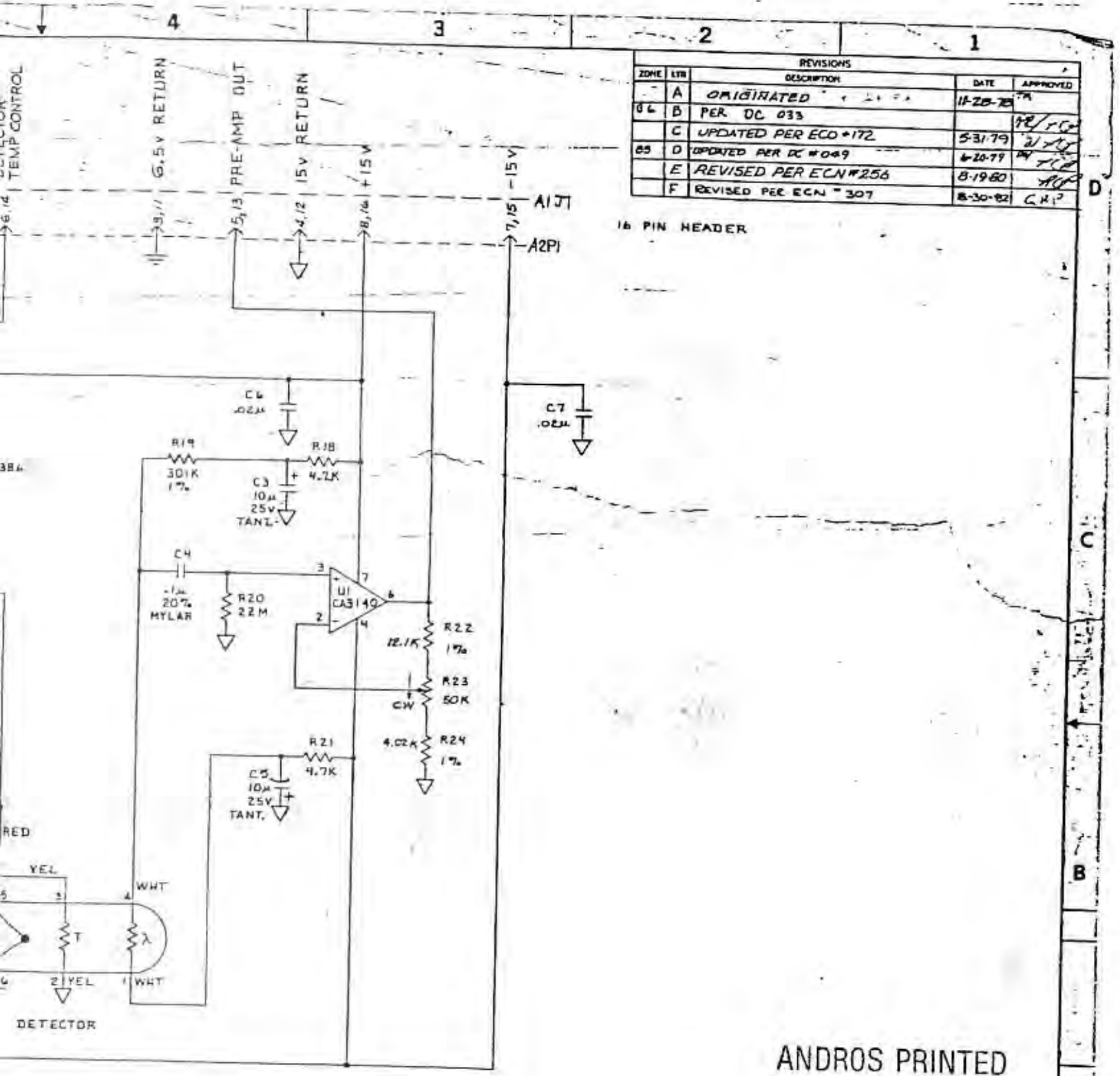


NOTES:

UNLESS OTHERWISE SPECIFIED

1) ALL RESISTORS TO BE IN OHMS 5% 1/4W CARBON FILM.
2) ALL 1% 1/8W RESISTORS ARE RN55D OR EQUIV.
3) ALL CAPS TO BE IN μFD'S ± 20%.
4) P.C.B. ASSY TO BE REF AS A2 ON INTERCONNECTION DIAGRAM # 771048.

COOLER PCBA 1



ANDROS PRINTED

AUG 7-1984

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

CONTRACT NO.

ANDROS INC BERKELEY CALIFORNIA

APPROVALS	DATE
DRAWN	8-2-78
CHECKED	12-7-78
	12-7-78

MATERIAL

FINISH

NEXT ASSY USED ON

APPLICATION

DO NOT SCALE DRAWING

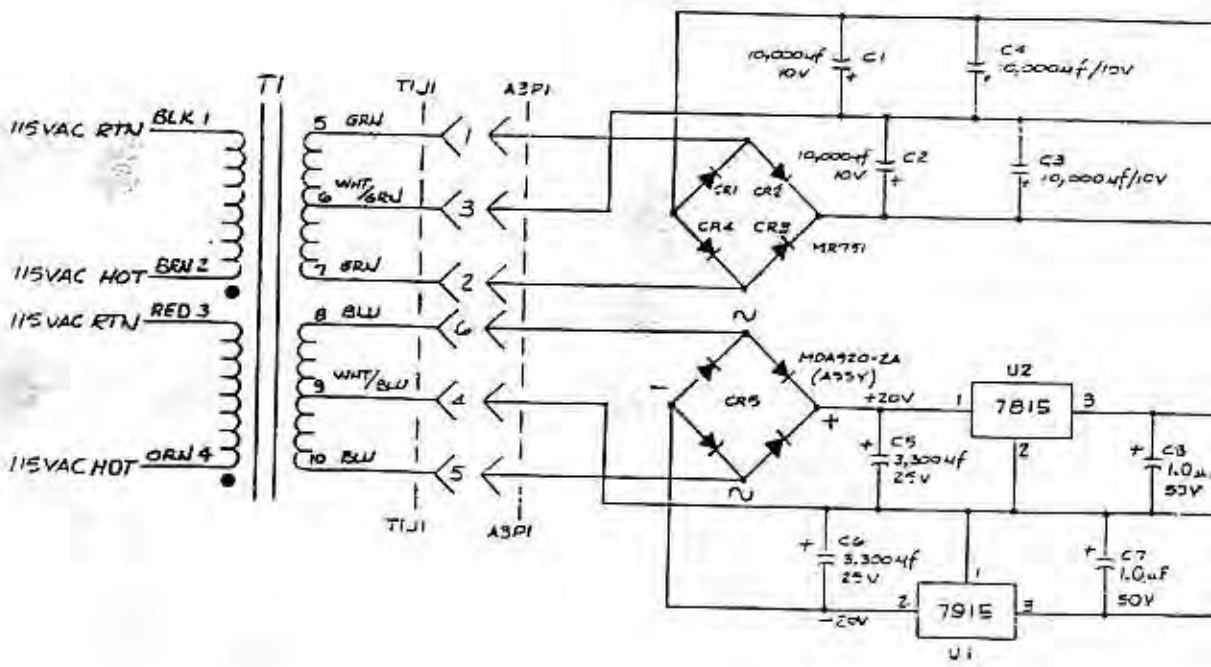
COOLER - PREAMP BOARD SCHEMATIC, STANDARD

SIZE D | CODE IDENT NO 50367 | DRAWING NO TR1021-003 | REV. F

SCALE — | SHEET 1 OF 1

COOL - PCBA 2

Appendix E-3



NOTE:
(UNLESS OTHERWISE SPECIFIED)

1) ALL RESISTORS TO BE IN OHMS 5% 1/4 W CARBON FILM.
2) ALL 1% 1/8 W RESISTORS ARE RN55D OR EQUIV.
3) ALL CAPS TO BE IN µFD'S.
4) P.C.B. ASSY TO BE REF AS A3 ON INTERCONNECTION DIAGRAM # 771018
5) T1 SHOWN FOR REFERENCE ONLY.

LAST COMPONENT DESIGNATIONS USED

CR 5
C 8
U 2

P501

REVISIONS			
ZONE	LTR	DESCRIPTION	DATE / APPROVED
	A	ORIGINATED	12-4-78
	B	PLATED PER ECO #224	7-10-79
	C	UPDATED PER ECO #224	4-28-80
	D	REVISED PER ECO # 232	5-13-80
	E	REVISED PER ECO #276	10-24-81

A3P2 A1J3

8,16 — -6.5V ±1% @ 3 AMP MAX.

4,14 — 6.5 GND

7,15 — +6.5V ±1% @ 3 AMP MAX.

1,9 — +15V±0.75@ 0.25 AMP MAX.

3,11 — 15V GND

2,10 — -15V ± 0.75@ 0.25 AMP MAX.

A3P2 A1J3 (PROCESSOR PCB)

ANDROS PRINTED

AUG 7 1984

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS DECIMALS ANGLES
.X ± = =
.XX ±

CONTRACT NO

APPROVALS	DATE
DRAWN	7 20 79
CHECKED	12-7-81
	12-7-81

MATERIAL

FINISH

DO NOT SCALE DRAWING

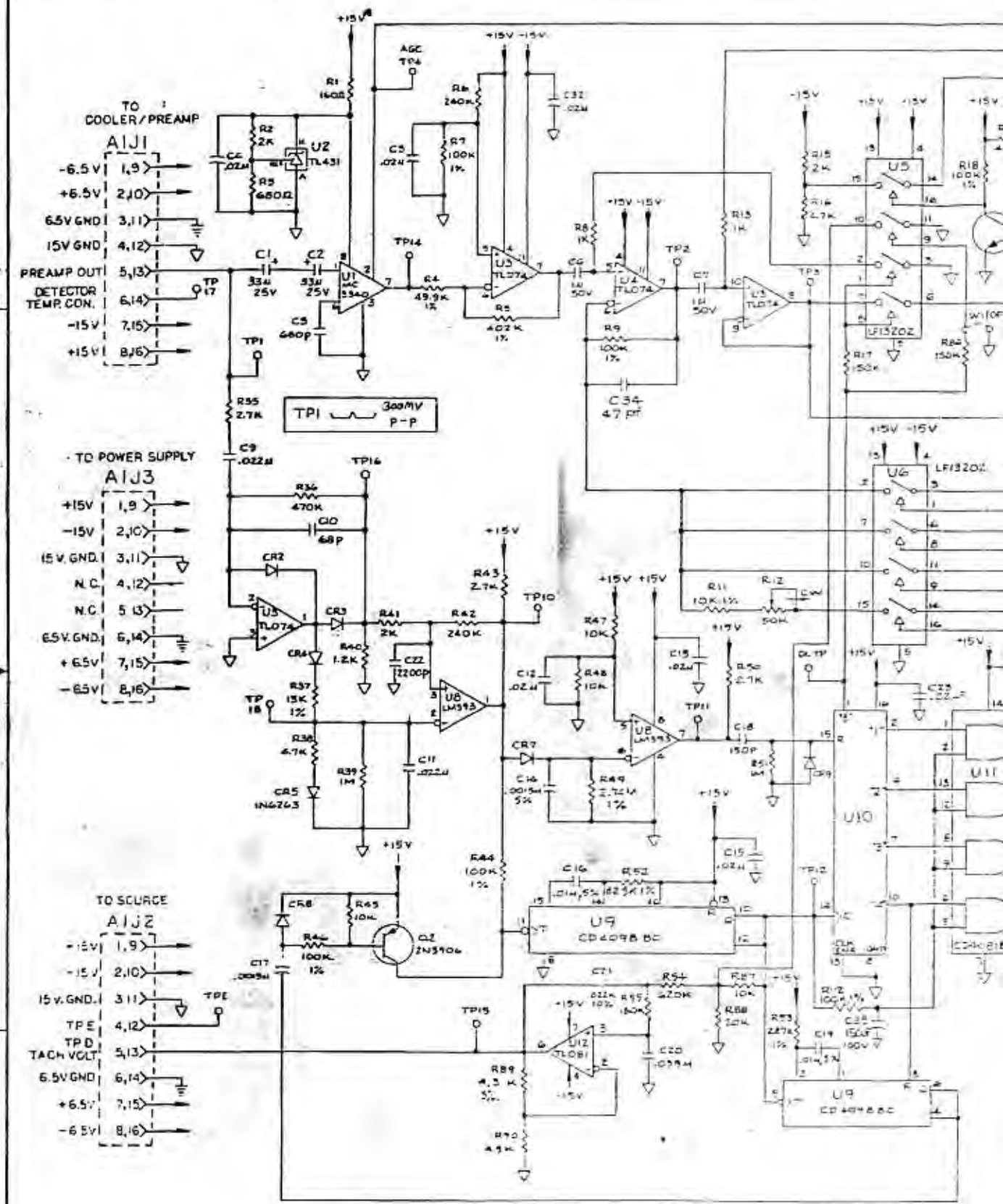
ANDROS INC BERKELEY CALIFORNIA

SCHEMATIC
POWER SUPPLY P.C.B.
A3

SIZE D | CODE IDENT NO 50357 | DRAWING NO 771023-000 | REV E

SCALE — | SHEET 1 OF 1

PSU 2


8
7
6
5
D
C
B
A
TO COOLER/PREAMP
A1J1
-6.5 V 1,9
+6.5V 2,10
6.5V GND 3,11
15V GND 4,12
PREAMP OUT 5,13
DETECTOR TEMP. CON. 6,14
-15V 7,15
+15V 8,16
TP17
TO POWER SUPPLY
A1J3
+15V 1,9
-15V 2,10
15 V. GND. 3,11
N. C. 4,12
N.C 5,13
6.5V. GND. 6,14
+6.5V 7,15
-6.5V 8,16
TO SOURCE
A1J2
+15V 1,9
-15 V 2,10
15 v. GND. 3,11
TP E 4,12
TP D TACH VOLT 5,13
6.5V GND 6,14
+6.5V 7,15
-6.5V 8,16
TPE
TP1 300MV P-P
AGC TP4
TP14
TP16
TP18
TP15
TP2
TP3
TP10
TP11
TP12
R1 160Ω
R2 2K
R3 680Ω
R4 49.9K 1%
R5 402K 1%
R6 240K
R7 100K 1%
R8 1K
R9 100K 1%
R11 10K 1%
R12 50K CW
R13 1K
R15 2K
R16 2.7K
R17 150K
R18 100K 1%
R34 470K
R35 2.7K
R36 4.7K
R37 13K 1%
R38 1.2K
R39 1M
R40 1.2K
R41 2K
R42 240K
R43 2.7K
R44 100K 1%
R45 10K
R46 100K 1%
R47 10K
R48 10K
R49 2.74K 1%
R50 2.7K
R51 10K
R52 82.5K 1%
R53 287K 1%
R54 220K
R55 82K 10%
R56 10K
R57 10K
R58 10K
R59 150K
R60 4.3K 5%
R61 4.99K
C1 .33µ 25V
C2 .33µ 25V
C3 .02µ
C5 .02µ
C6 .02µ
C7 1µ 50V
C8 1µ 50V
C9 .022µ
C10 68P
C11 .022µ
C12 .02µ
C15 .02µ
C16 .01µ 5%
C17 .0015µ
C18 150P
C19 .01µ 5%
C20 .039µ
C21 .01µ 5%
C22 2200P
C23 .02µ
C31 .02µ
C34 47 pF
C35 150µF 100V
U1 LM334
U2 TL431
U3 TL074
U4 TL074
U5 LF13202
U6 LF13202
U8 LM393
U9 CD4098 BC
U10
U11
U12 TL081
CR2
CR3
CR4
CR5 IN4763
CR7
CR8
Q2 2N5906
SW1 OFF
DL TP
TPI 300MV P-P
NOTES: (UNLESS OTHERWISE SPECIFIED)
1. CR1-CR4 & CR7-CR8 ARE IN4148
2. ALL RESISTORS 1/4W, 5% CARBON FILM.

A PCBA 1

E-T — Processor PCB, Rev. E Schematic 7/1046-000

REVISIONS			
ZONE	LTR	DESCRIPTION	DATE
	A	CO2 SIGNATURE PER ECN 8-001	12-84
	B	CHANGES PER ECN 8-001	2-85
	C	REVISED PER ECN 8-002	4-85
	D	REVISED PER ECN 290	4-6-92
	E	REV'D PER ECN # AAA	1-1-93

A1P1

9	CAL COM
6	CO ZERO
7	HC ZERO
5	CO_2 ZERO
8	COM. GND
10,24,25	SIG. GND
13	CO_2 SIG.
14	
15	CO_2 FULL SCALE ADJ.
20	
21	CO_2 CAL ADJ.
11	HC SIG.
4	HC FULL SCALE ADJ.
3	
16	HC CAL ADJ.
17	
12	CO SIG.
1	CO FULL SCALE ADJ.
2	
18	CO CAL ADJ.
19	
22	-15V
23	N.C.
15	+15V

A1J4

TP3	1	PRO MUX SIG/SIG
+15V	2	+15V
-15V	3	-15V
15VGND	4	15V GND
TP6	5	HC SIG
TP7	6	CO SIG
TP5	7	CO_2 SIG
TP4	8	AGC
TP12	9	SAMPLE PERIOD GEN
OL TP	10	SCOPE SYNC
TP10	11	CASE ECTOR TEMP CONT
15VGND	12	15V GND
TP14	13	PAGC AMP
-8.5V	14	-8.5V
+8.5V	15	+8.5V
TP8	16	FILTER WHEEL TEMP CONT

HIGHEST REFERENCE DESIGNATOR
U19
R115
C38
CR15
Q2
RN2
RT3

ANDROS PRINTED

AUG 7 1994

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION
PARTS LIST			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

CONTRACT NO

APPROVALS	DATE
DRAWN	4-10-87
CHECKED	10-87
ENGINEER	10-87

MATERIAL

FINISH

DO NOT SCALE DRAWING

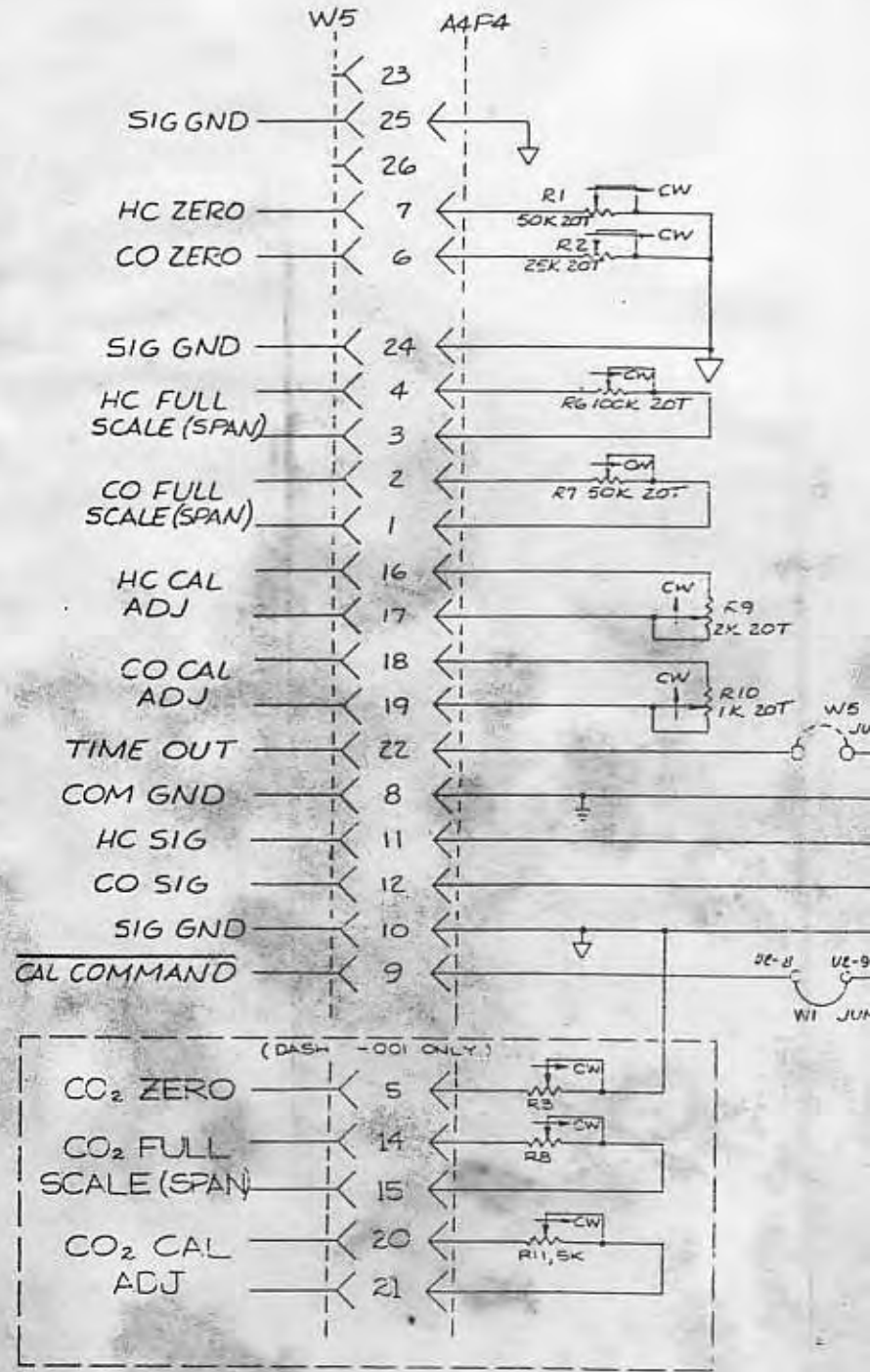
ANDROS INC BERKELEY CALIFORNIA

SCHEMATIC DIAGRAM
ANALOG PROCESSOR PCB

SIZE D | CODE IDENT NO 50367 | DRAWING NO 7/1046-000

SCALE — | SHEET —

A PCB A2



INTERFACE PCBA 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ORIGINATED	4-10-79	[illegible]
	B	ECN 359 - ADDED -001,	7-12-83	[illegible]

ER, 22AWG BUS

(36) TIME OUT

(1) COMMAND GROUND

(7) HC SIGNAL

(11) CO SIGNAL

(8) SIGNAL GROUND

(5) $\overline{\text{CAL COMMAND}}$ (ELECT CAL)

ER, 22AWG BUS

ANDROS PRINTED

AUG 8 19[illegible]

INTER

OCBA 2

REPRESENTS 7ASN CCO & DAS- 00

QTY PER UNIT	CODE CLNT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
			PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS = DECIMALS .XX = .XXX = ANGLES =

MATERIAL

FINISH

NEXT ASSY USED ON

APPLICATION

DO NOT SCALE DRAWING

CONTRACT NO

APPROVALS	DATE
DRAWN [illegible]	4-5-79
CHECKED [illegible]	4-10-79
[illegible]	4-17-79

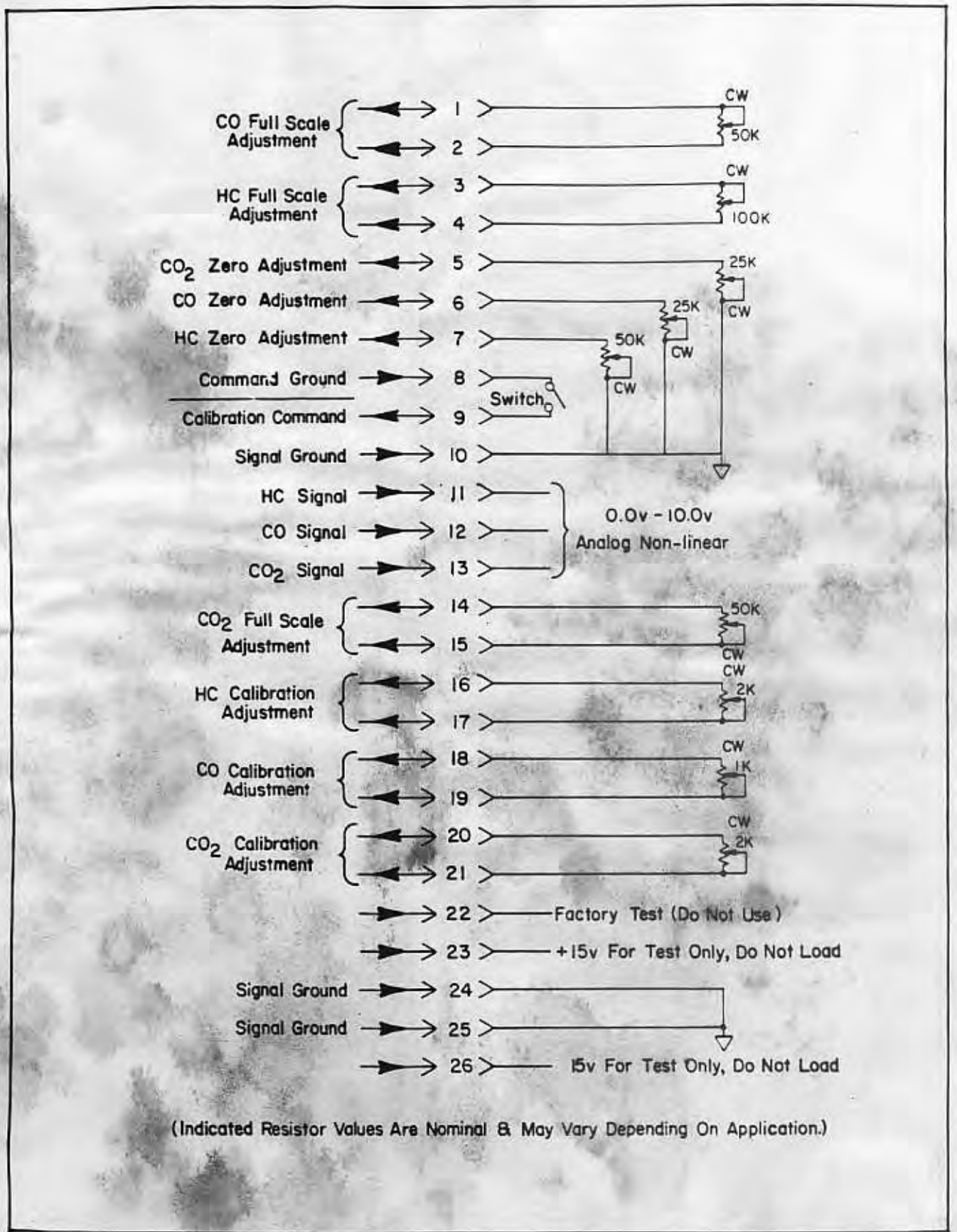
ANDROS INC BERKELEY CALIFORNIA

SCHEMATIC, INTERFACE
RADIM 2 & 3

SIZE D | CODE IDENT NO 50367 | DRAWING NO 77105D-[illegible] | REV

SCALE — | SHEET [illegible] OF [illegible]

E-5 -- Interface Connector Pinout Assignments Table



(Indicated Resistor Values Are Nominal & May Vary Depending On Application.)

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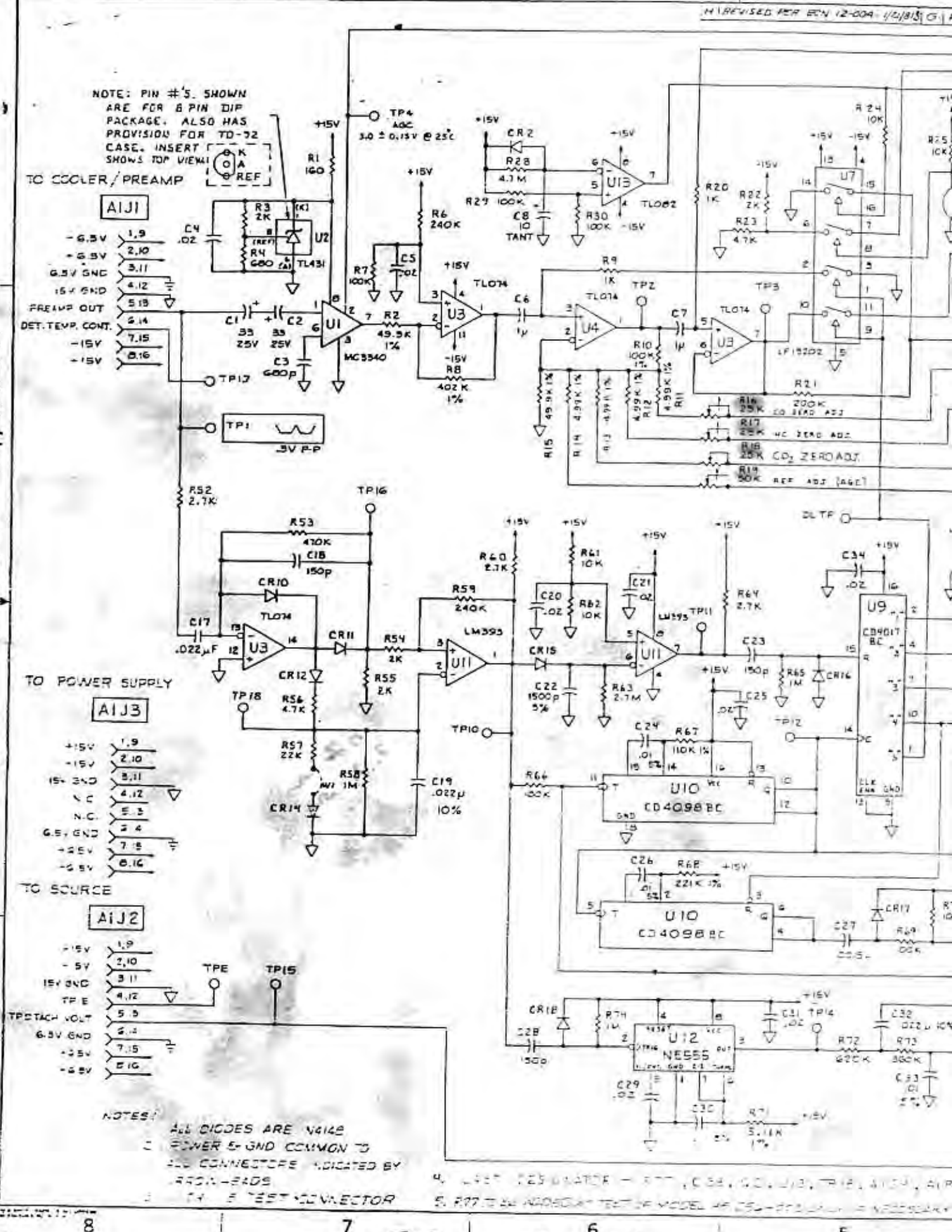
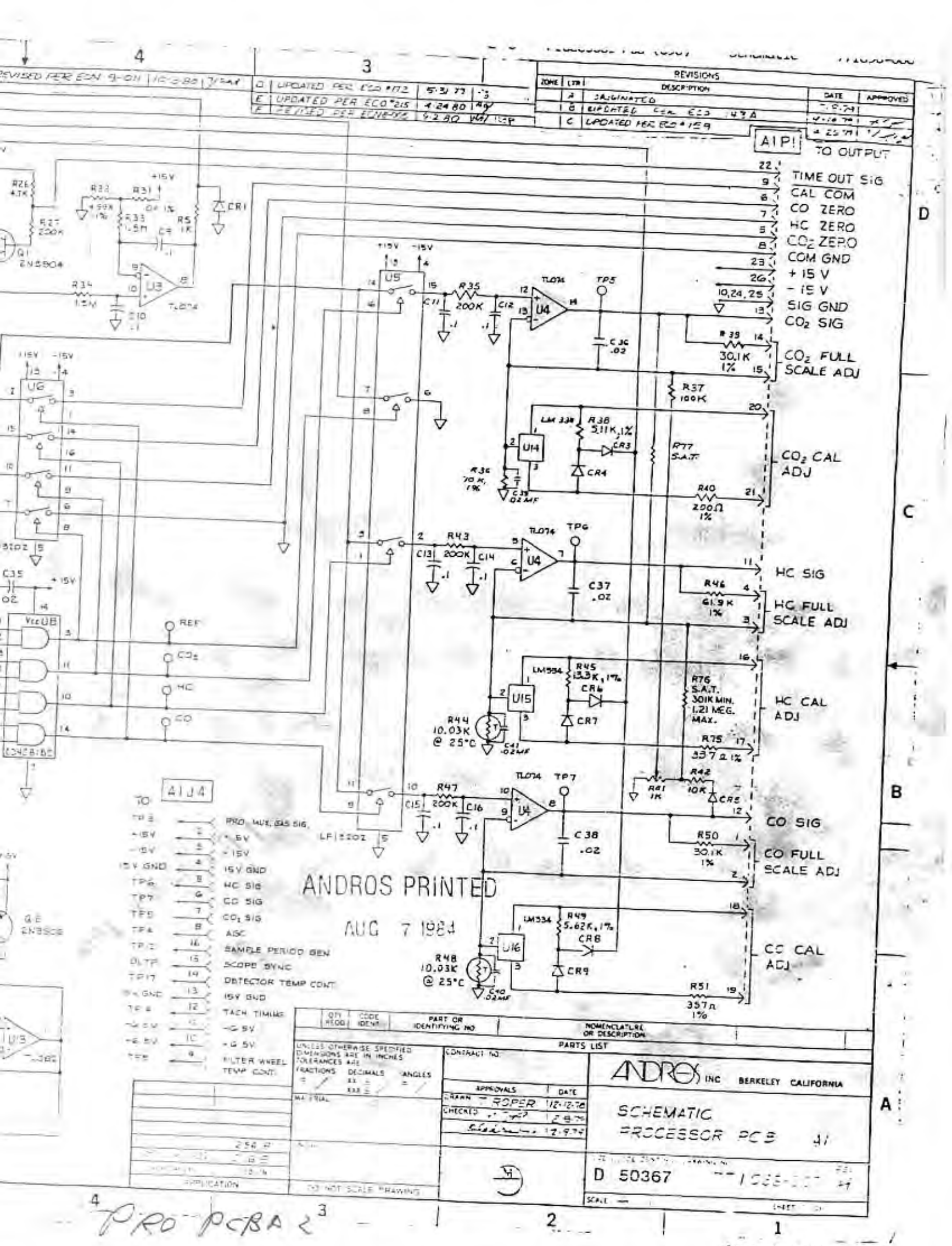
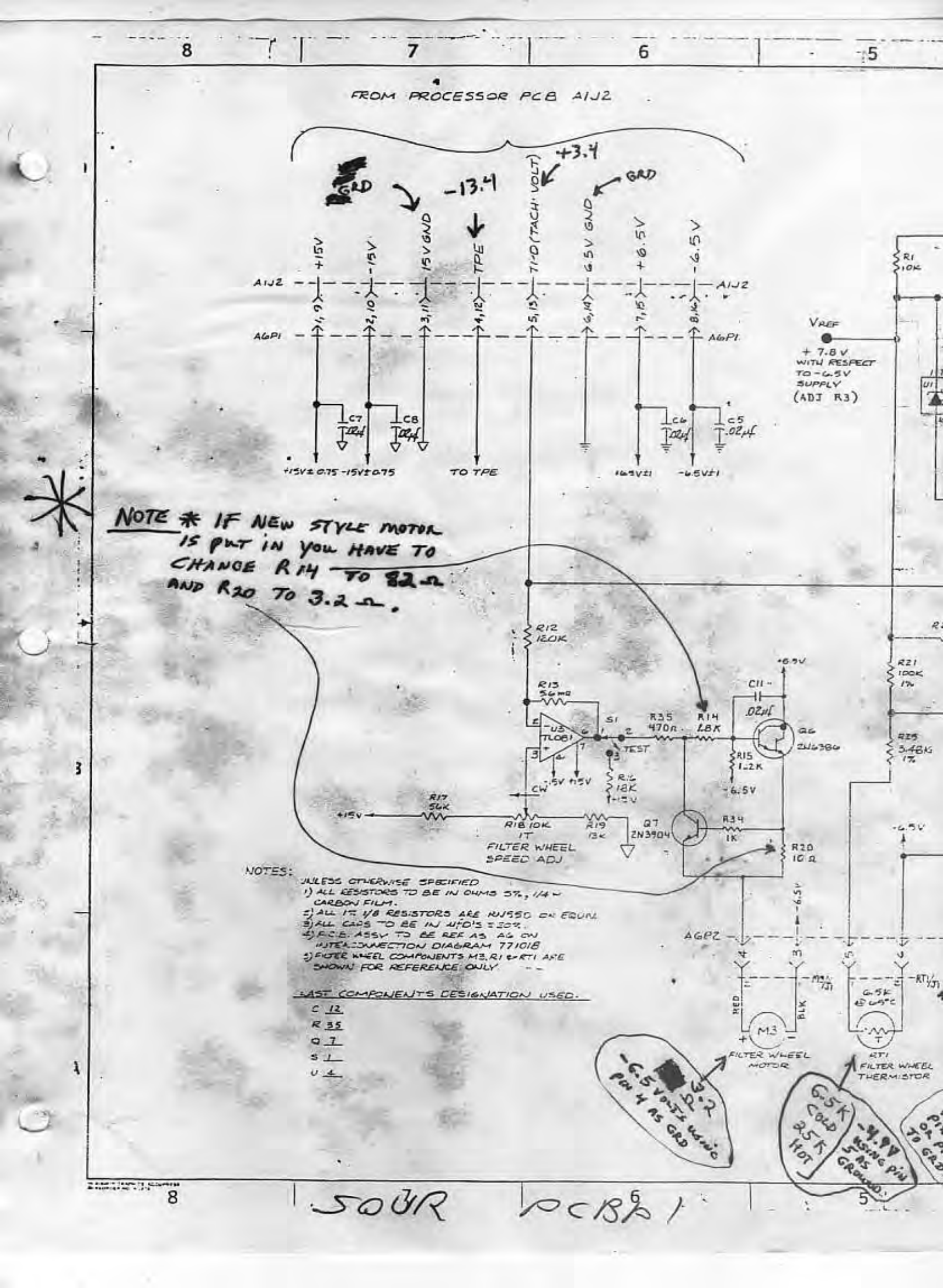

NOTE: PIN #'S. SHOWN ARE FOR 8 PIN DIP PACKAGE. ALSO HAS PROVISION FOR TO-92 CASE. INSERT SHOWS TOP VIEW
TO COOLER / PREAMP
A1J1
-6.5V
+6.5V
6.5V GND
15V GND
PREAMP OUT
DET. TEMP. CONT.
-15V
+15V
TP4 AGC 3.0 ± 0.15V @ 25C
TP17
TP1 .5V P-P
TP2
TP3
TP16
TP11
TP12
TP10
TP18
TP8
TP15
TP14
TO POWER SUPPLY
A1J3
+15V
-15V
15V GND
N.C.
6.5V GND
+6.5V
-6.5V
TO SOURCE
A1J2
+15V
-15V
15V GND
TP E
TP TACH VOLT
6.5V GND
+6.5V
-6.5V
TL074
MC3340
TL431
LM393
LF13202
CD4017 BC
CD4098 BC
NE555
R1 160
R2 49.9K 1%
R3 2K
R4 680
R6 240K
R7 100K
R8 402K 1%
R9 1K
R10 100K 1%
R11 4.99K 1%
R12 4.99K 1%
R13 4.99K 1%
R14 4.99K 1%
R15 49.9K 1%
R16 25K CO ZERO ADJ
R17 25K HC ZERO ADJ
R18 25K CO2 ZERO ADJ.
R19 50K REF ADJ (AGC)
R20 1K
R21 200K
R22 2K
R23 4.7K
R24 10K
R25 10K
R28 4.7M
R29 100K
R30 100K
R52 2.7K
R53 470K
R54 2K
R55 2K
R56 4.7K
R57 22K
R58 1M
R59 240K
R60 2.7K
R61 10K
R62 10K
R63 2.7M
R64 2.7K
R65 1M
R66 100K
R67 110K 1%
R68 221K 1%
R69 100K
R72 620K
R73 300K
C1 33 25V
C2 33 25V
C3 680p
C4 .02
C5 .02
C6 1µ
C7 1µ
C8 10 TANT
C17 .022µF
C18 150p
C19 .022µ 10%
C20 .02
C21 .02
C22 1500p 5%
C23 150p
C24 .01
C25 .02
C26 .01 5%
C27 .022µ
C28 150p
C29 .02
C30 .01
C31 .02
C32 .022µ 10%
C33 .01 5%
C34 .02
CR2
CR10
CR11
CR12
CR14
CR15
CR16
CR17
CR18
U1
U2
U3
U4
U7
U8
U9
U10
U11
U12
U13
NOTES:
1. ALL DIODES ARE 1N4148
2. POWER & GND COMMON TO ALL CONNECTORS INDICATED BY ARROW-HEADS
3. 14 PIN SOCKET FOR IC
4. LAST TEST LOCATION = R77, C34, C32, U13, TP18, A1J3, A1P
5. R77 TO BE ADJUSTED TEST OF MODEL IF CO2 CHANNEL IS NOT NECESSARY

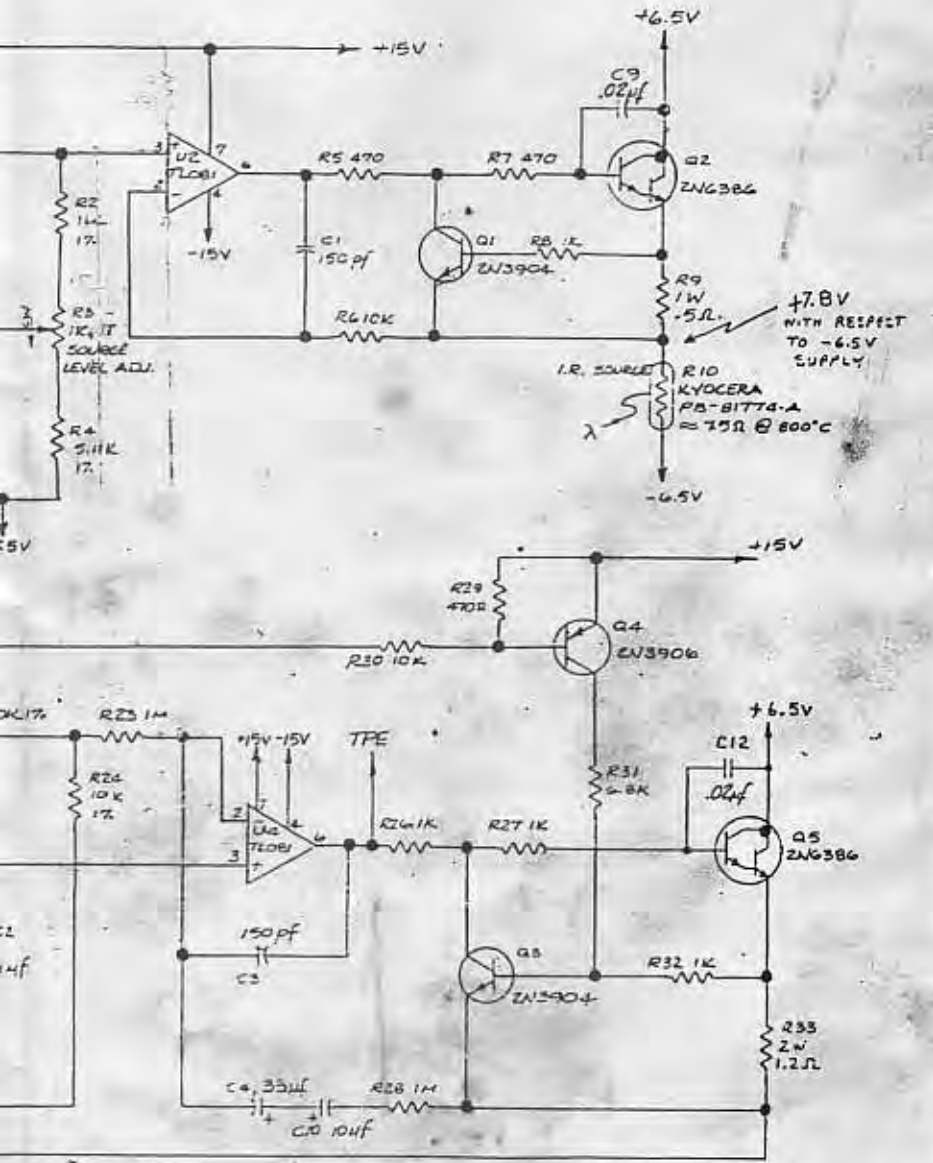
PRO PCB A1


REVISIONS
ZONE | LTR | DESCRIPTION | DATE | APPROVED
A | ORIGINATED
B | REVISED PER ECO #215
C | UPDATED PER ECO #159
AIP1
TO OUTPUT
TIME OUT SIG
CAL COM
CO ZERO
HC ZERO
CO2 ZERO
COM GND
+ 15 V
- 15 V
SIG GND
CO2 SIG
CO2 FULL SCALE ADJ
CO2 CAL ADJ
HC SIG
HC FULL SCALE ADJ
HC CAL ADJ
CO SIG
CO FULL SCALE ADJ
CO CAL ADJ
TL074
LM334
R35 200K
R43 200K
R47 200K
R37 100K
R39 30.1K 1%
R46 61.9K 1%
R50 30.1K 1%
R51 357Ω 1%
R75 357Ω 1%
R36 70K, 1%
R38 5.11K, 1%
R77 S.A.T.
R40 200Ω 1%
R45 13.3K, 1%
R76 S.A.T. 301K MIN. 1.21 MEG. MAX.
R49 5.62K, 1%
R44 10.03K @ 25°C
R48 10.03K @ 25°C
R41 1K
R42 10K
A1J4
TO
TP3 PRO. MUX, GAS SIG.
+15V +5V
-15V -15V
15V GND 15V GND
TP6 HC SIG
TP7 CO SIG
TP5 CO2 SIG
TP4 AISC
TP12 SAMPLE PERIOD GEN
DLTP SCOPE SYNC
TP17 DETECTOR TEMP CONT
15V GND 15V GND
TP8 TACH TIMING
-5V -5V
+5V +5V
TP9 FILTER WHEEL TEMP CONT
ANDROS PRINTED
AUG 7 1984
PARTS LIST
ANDROS INC BERKELEY CALIFORNIA
SCHEMATIC
PROCESSOR PCB
D 50367
DRAWN ROPER 12-12-78
Appendix E-19

PRO PCBA 2


FROM PROCESSOR PCB A1J2
GRD
-13.4
+3.4
+15V
-15V
15V GND
TPE
TACH (TACH VOLT)
6.5V GND
+6.5V
-6.5V
A1J2
AGP1
1,9
2,10
3,11
4,12
5,13
6,14
7,15
8,16
C7 .02µf
C8 .02µf
C6 .02µf
C5 .02µf
+15V±0.75
-15V±0.75
TO TPE
6.5V±1
-6.5V±1
VREF
+7.8 V WITH RESPECT TO -6.5V SUPPLY (ADJ R3)
R1 10K
NOTE * IF NEW STYLE MOTOR IS PUT IN YOU HAVE TO CHANGE R14 TO 82Ω AND R20 TO 3.2Ω.
R12 120K
R13 56mΩ
U3 TL081
S1
R35 470Ω
R14 1.8K
C11 .02µf
Q6 2N6386
TEST
R15 1.2K
-6.5V
R16 18K
+15V
CW
R17 5K
R18 10K 1T FILTER WHEEL SPEED ADJ
R19 13K
Q7 2N3904
R34 1K
R20 10Ω
+6.5V
R21 100K 1%
R25 3.48K 1%
AGP2
RED
BLK
M3
FILTER WHEEL MOTOR
RT1
6.5K @ 25°C
RT1 FILTER WHEEL THERMISTOR
3.2Ω -6.5 VOLTS MUSIC PIN 4 AS GRD
6.5K COLD 2.5K HOT
-4.9V MUSIC PIN 5 AS GROUND
NOTES:
UNLESS OTHERWISE SPECIFIED
1) ALL RESISTORS TO BE IN OHMS 5%, 1/4 W CARBON FILM.
2) ALL 1% 1/8 RESISTORS ARE NJ55D OR EQUIV.
3) ALL CAPS TO BE IN µFD'S ±10%
4) P.C.B. ASSY TO BE REF AS AG ON INTERCONNECTION DIAGRAM 771018
5) FILTER WHEEL COMPONENTS M3, R1 & RT1 ARE SHOWN FOR REFERENCE ONLY
LAST COMPONENTS DESIGNATION USED.
C 12
R 35
Q 7
S 1
U 4
50ΩR PCB#1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ORIGINATED	12-12-78	
	B	UPDATED PER ECO # 142	3-22-79	
	C	UPDATED PER ECO # 171	5-22-79	
	D	REV PER ECN #250	12-11-81	REP
	E	REVISED PER ECN # 294	12/8/82	



ANDROS PRINTED

AUG 7 1984

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

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TOLERANCES ARE:
FRACTIONS ± DECIMALS XX = ± ANGLES = ±
XXX =

CONTRACT NO

ANDROS INC BERKELEY CALIFORNIA

APPROVALS	DATE
DRAWN	
CHECKED	7-12-79

MATERIAL

SCHEMATIC DRAWING
SOURCE P.C.B.
A3

FINISH

SIZE D | CODE IDENT NO | DRAWING NO 50367 | REV E

NEXT ASSY | USED ON

APPLICATION | DO NOT SCALE DRAWING

SCALE | SHEET OF

FOUR PCBA'S

E-11 -- Test Connector Pinout Assignments Table

Pin #	Description	Remarks
1	PRO MUX Gas Signal	Same as TP3
2	+15 volts	
3	-15 volts	
4	+/- 15 volts ground	0 volts
5	HC signal	Same as TP6
6	CO signal	Same as TP7
7	CO2 signal	Same as TP5
8	AGC	Same as TP4
9	Filter Wheel Temp. Control	Same as TPE
10	+6.5 volts	
11	-6.5 volts	
12	AGC Amplifier	Same as TP14
13	+/-6.5 volt ground	0 volts
14	Detector Temperature Control	Same as TP17
15	DLTP	Same as DLTP
16	Sample Period Generator	Same as DLTP

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Appendix F - User Comments

Your comments are valued about Bench 200, customer service, this manual, or any improvements you believe would help you use Bench 200.

Please send your comments to:

Customer Service Manager
Andros Analyzers, Inc.
2332 Fourth Street
Berkeley, CA 94710
(415/849-1377)

Appendix G - Glossary

Most terms are defined when first used in the text. The following additional information is provided for the general reader.

AGC - Automatic Gain Control

Bench - term for the assembly of infrared emitter, filters, prisms, sample cell, and detector used to analyze gases.

Bench 200 - a non-dispersive, single path bench; taken to include the electronics components needed to control and interface with a parent system.

CO2 - Carbon dioxide

CO - Carbon monoxide

CRO - Cathode ray oscilloscope (oscilloscope)

DLTP - Dark Level Test Point

DMM - Digital multimeter

HC - Hydrocarbons

LPM - Liters per minute

N2 - Nitrogen

NDIR - Non-dispersive infrared

OEM - Original equipment manufacturer

Pedestal - Pulse measurement of output from the Selective Gain Amplifier (TP3)

PEF - Propane Equivalency Factor

SW - Switch

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Terms marked with an asterisk (*) are in the glossary.

Chapters each have detailed tables of contents.

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APPLICATION		REVISION HISTORY			
NEXT ASSY	USED ON	LTR	DESCRIPTION	DATE	APPROVED
SEE	MIS	A	ERN# 2495	1-10-88	[illegible]
		A1	ECN 1014	5/17/89	RFP
		A2	ECN 2020	3/6/91	JR

NOTE:

1) MACHINE TEXT FILE IS IN MICROSOFT WORD ON MARKETING MACINTOSH.

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	APPROVALS / DATE		
MATERIAL ~	DRAWN S. TERREDA 3/21/88	INSTRUCTION, B'LESS RETRO FIT	
	CHECKED [illegible] 3/9/88		
FINISH ~	[illegible] 3/17/89	SIZE A	DRAWING NO. 990005-000 REV. SEE ABOVE
DO NOT SCALE DRAWING		SCALE NONE	SHEET 1 OF 8

BISHOP GRAPHICS/ACCUPRESS REORDER NO A15425

APPLICATION BULLETIN

SUBJECT: Chopper Motor Upgrade, Models 256B and 257E

Andros is pleased to announce a new brushless DC motor for new production and field retrofit of all Andros models 256B and 257E. The new brushless DC motor will be incorporated into production in July, 1988.

This new motor is a result of Andros' continuing effort to provide even higher reliability in it's 200 series products. Recognizing that 40% of field failures are directly related to the current motor, Andros has specified and developed a new chopper motor which has a minimum MTBF of 25,000 hours which is equivalent to a seven (7) to twelve (12) year life. Additionally, the motor/heatsink assembly has been configured to allow easy installation into field units at the depot level.

The motor replacement kit can be obtained by ordering Andros part numbers 453020-000 or 453020-001. Both kits include the motor and heatsink assemblies, plus the two (2) replacement resistors for R14 and R20.

To obtain the kit with the motor mount tool, please order Andros part number 453020-001. This kit should be ordered when outfitting the field service personnel during the initial phase of motor exchange.

The motor mount tool will be required when installing the filter wheel onto the motor shaft to prevent damage to the motor bearings. The tool will be available as a separate part number (AAI P/N 435008-000). Additional tools may be ordered at any time, either as an individual item or included with the replacement motor kit.

The following item list indicates the two (2) different kits being made available for the replacement of the motor/heatsink assembly.

AAI P/N 453020-000

Item 1 AAI P/N 230824-005, Resistor, 82 ohms, 1/4 W, 5%, R14
Item 2 AAI P/N 230034-005, Resistor, 3 ohms, 1/4W, R20
Item 3 AAI P/N 821080-000, Heatsink, Q6
Item 4 AAI P/N 451269-003, Motor/Heatsink Assembly
Item 5 AAI P/N 610104-006, Screw #4
Item 6 AAI P/N 620204-000, Lock Washer #4
Item 7 AAI P/N 620304-000, Nut #4
Item 8 AAI P/N 831035-000, Tape 5 '8" Diameter, Adhesive
Item 9 AAI P/N 990005-000, Application Bulletin

AAI P/N 453020-001

Items 1 through 9 above, plus Item 10 AAI P/N 435008-000, Motor Mount Tool.

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SIZE		DRAWING NO.
A		990005-000 A2
SCALE		SHEET 2 OF 8

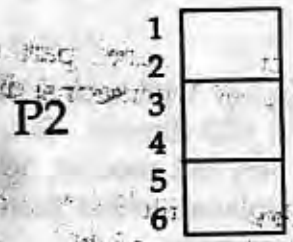
BISHOP GRAPHICS/ACCUPRESS REORDER NO A15424

1.0 INSTALLATION PROCEDURES, MOTOR/HEATSINK REMOVAL

1.1 The removal and replacement of the motor/heatsink assembly is accomplished by first removing the three (3) screws used to secure the processor PCB to the base-plate assembly, and then removing the PCB from the base assembly.

1.2 Next, the two (2) screws used to secure the motor/heatsink assembly to the sample cell are loosened, but not removed.

1.3 Disconnect the three (3) sets of wires attached to P2 on the source PCB. These are the thermistor assembly, motor and strip heater connections to their respective servo circuits.



Thermister Assembly

Motor

Heater Strip

1.4 The source PCB (AAI P/N 451020-000) can then be extracted by removing the screw located directly below Q4. Gently remove the source and PCB by sliding the source assembly out of the filter wheel housing.

1.5 The motor and heatsink are next removed by extracting the loosened screws and by gently pulling straight back on the heatsink assembly.

1.6 The filter wheel is them removed from the motor shaft by prying the wheel upwards, or away from the insulator assembly using a thin knife blade or other device suitable to apply force to the hub of the wheel.

NOTE: Take care that when removing the filter wheel assembly that you do not touch the filters or allow them to get dirty in any way.

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BISHOP GRAPHICS/ACCUPRESS REORDER NO. A15424

2.0 INSTALLATION PROCEDURES, MOTOR/HEATSINK REPLACEMENT

2.1 Setting the replacement motor/heatsink assembly (AAI P/N 451269-003) over the motor mount tool (AAI P/N 435008-000) as shown in Figure 1.0, install the filter wheel onto the motor shaft by pressing down on the center of the wheel with the thumb until the wheel is completely seated on the shaft of the motor. Do not use excessive force.

NOTE: DO NOT ATTEMPT TO INSTALL THE FILTER WHEEL ONTO THE MOTOR SHAFT WITHOUT USING THE MOTOR MOUNT TOOL. SEVERE DAMAGE TO THE MOTOR WILL OCCUR IF THIS TOOL IS NOT USED.

2.2 Make sure that the thermistor bead is no more that 0.030 inches from the inner surface of the filter wheel to ensure that the heater circuitry operates correctly.

2.03 To reassemble the bench reverse steps 1.5 through 1.1.

3.0 SOURCE PCB MODIFICATIONS

One set of two (2) each resistors is supplied with each parts kit. This set of resistors is provided to replace R14 and R20 directly. Since the value of R20 can be 6.5 ohm, 10 ohm, or in the case of very old product, 16 ohms, it is recommended that the two (2) resistors be replaced, rather than bridged with a parallel resistor, to obtain the desired equivalent value.

The new values for R14 and R20 are as follows:

R14 was 1.8 K ohms changed to 82 ohms
R20 was 6.5 ohms changed to 3 ohms

Additionally, Q6 on the source PCB will require that a heatsink be installed. This is supplied in the parts kit along with #4 mounting hardware. Refer to Figure 1.1 for location of R14, R20, and Q6. Figure 1.2 is the schematic indicating R14 and R20 in the circuit.

Figure 1.3 is supplied as a reference sketch representing the heatsink for Q6.

4.0 PLACEMENT OF 5/8" ADHESIVE TAPE

After the motor/heatsink assembly (AAI P/N 451269-003) has been mounted to the unit (using the Motor Mount Tool) the 5/8" Diameter Adhesive Tape (AAI P/N 831035-000) needs to be attached to the end of the motor (as illustrated in Figure 1) to prevent dust from entering the motor.

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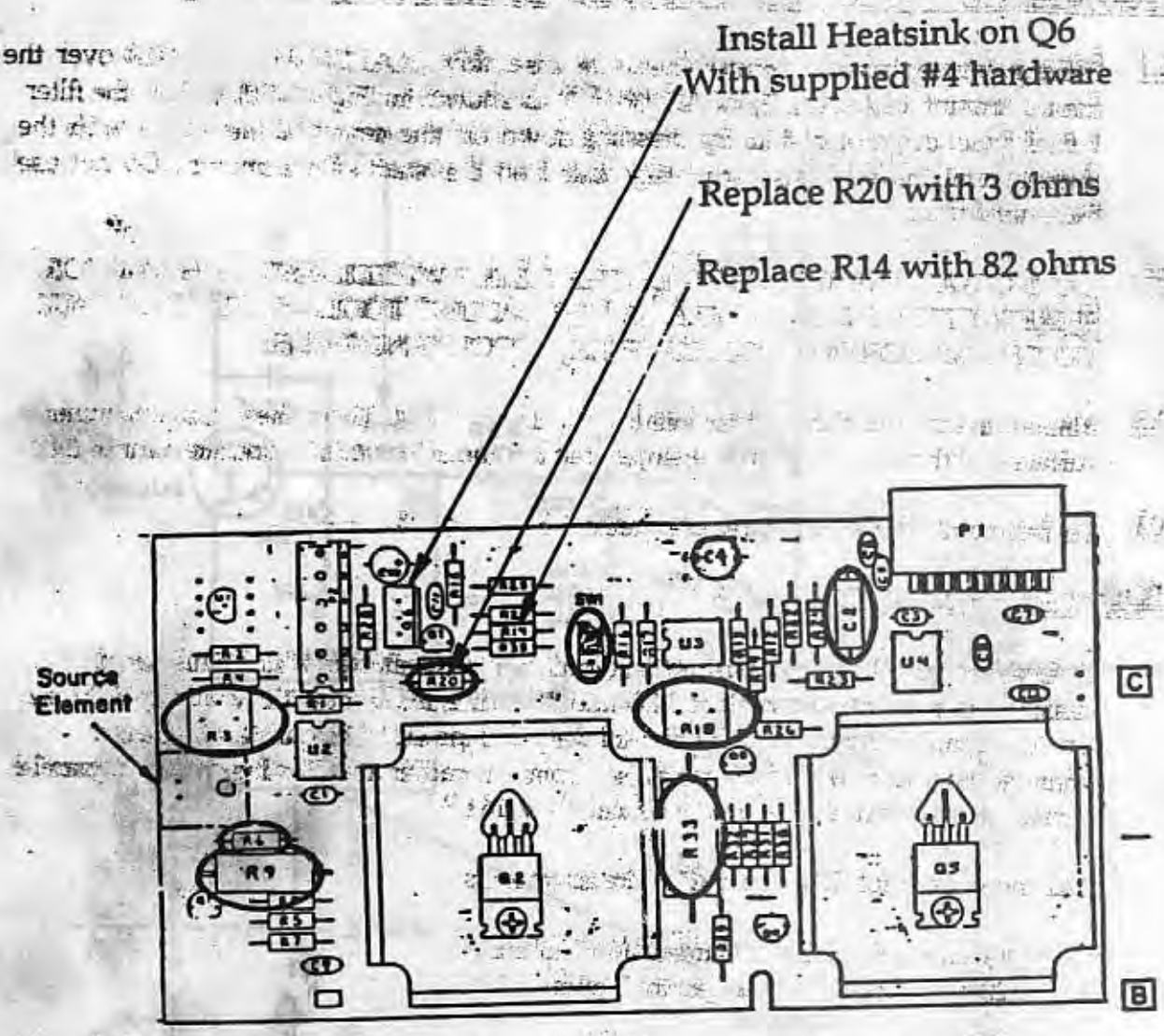

Fig. 1.1

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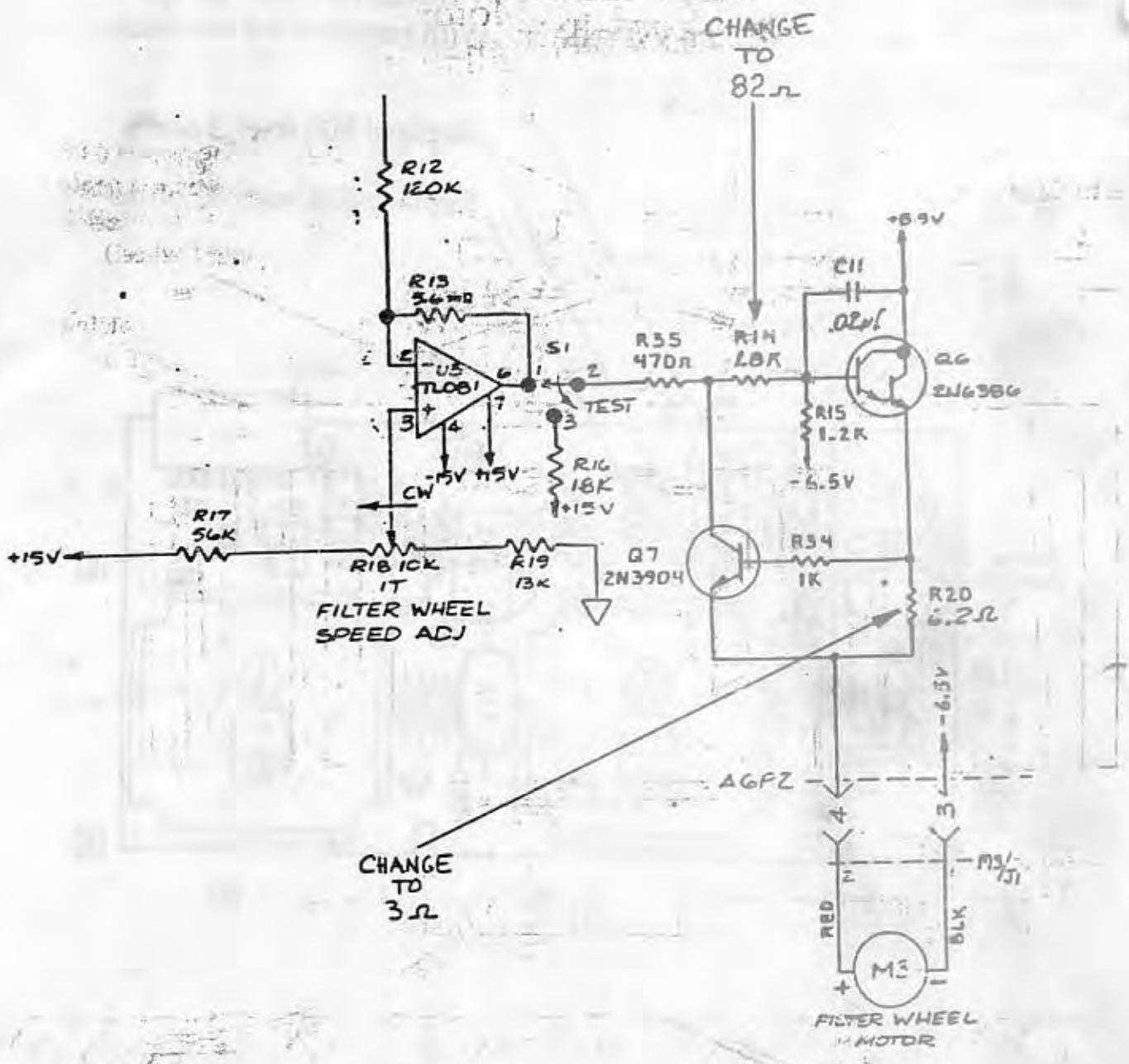

Fig. 1.2

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BISHOP GRAPHICS ACCUPRESS

Brushless DC Motor - Filter Wheel Installation

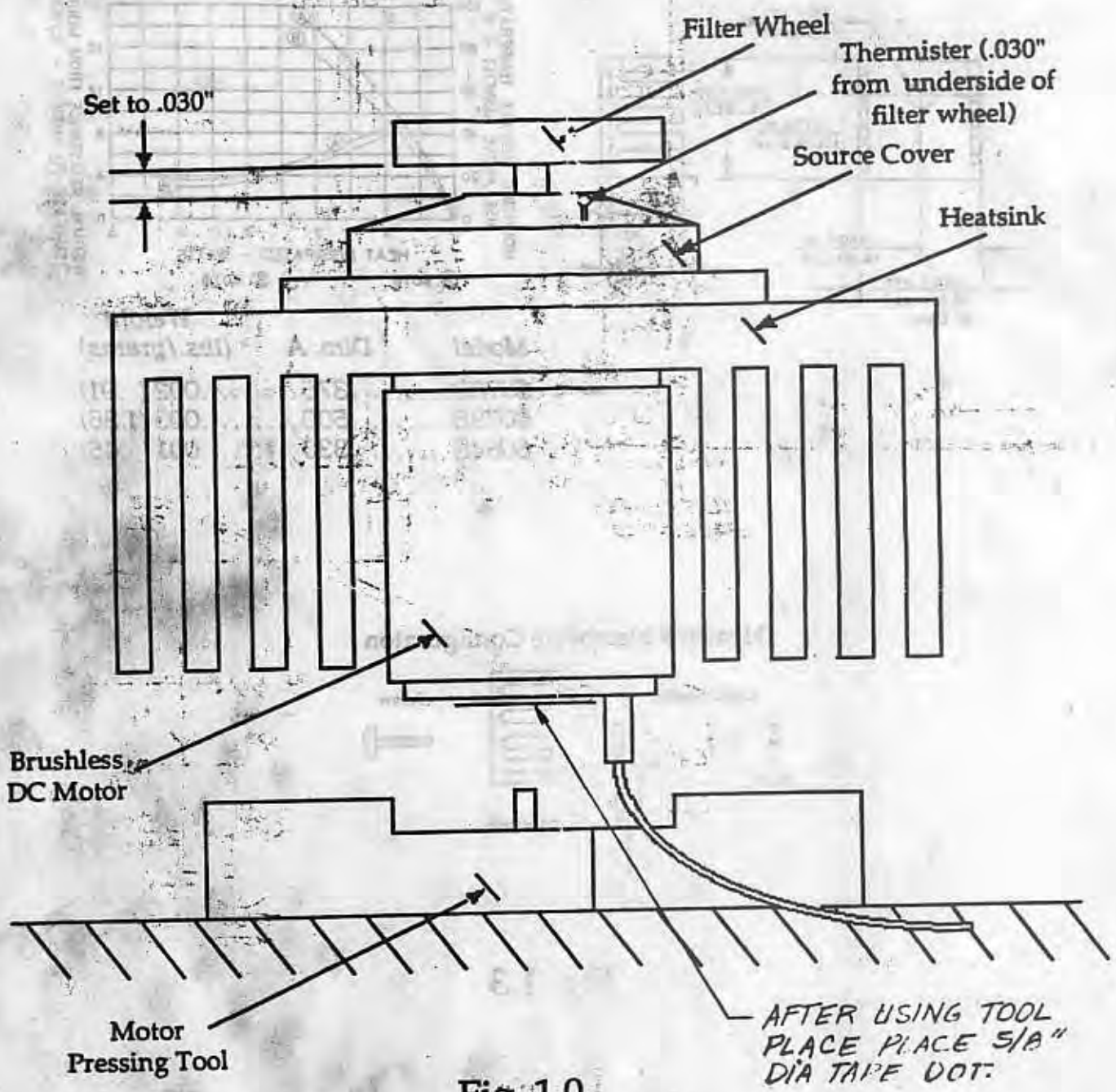

Fig. 1.0

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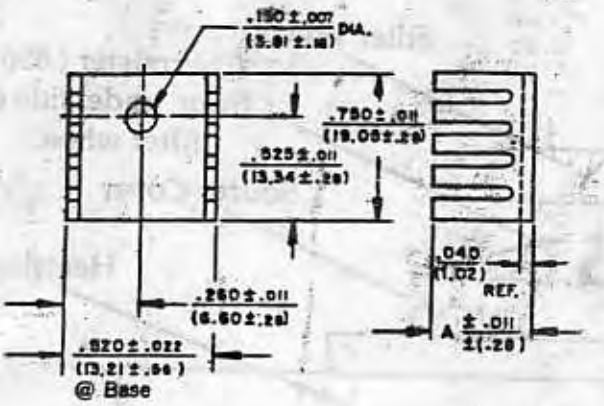
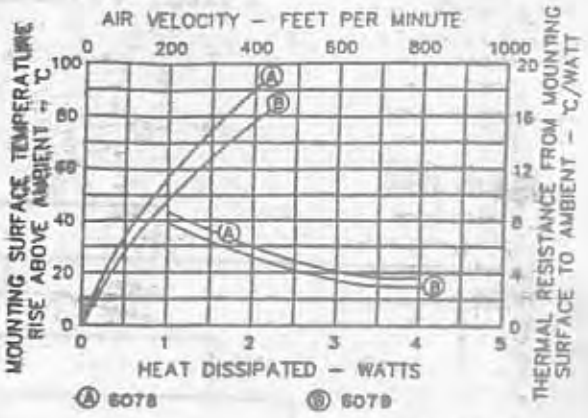
BISHOP GRAPHICS/ACCUPRESS

TO-220 Lo-Pro Heatsink





Model	Dim. A	Weight (lbs./grams)
6078B	.375	.002 (.91)
6079B	.500	.003 (1.36)
6084B	.330	.001 (.45)

Heatsink Hardware Configuraton

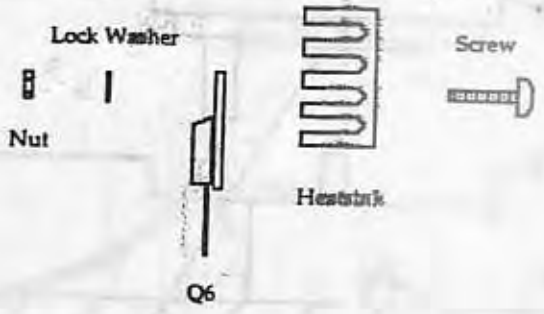


Fig. 1.3

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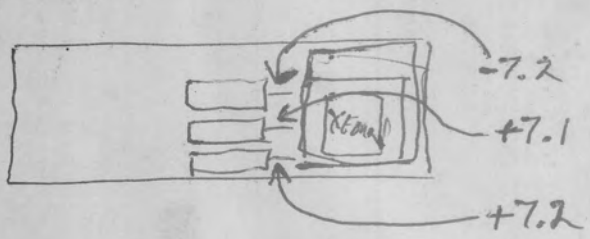
BISHOP GRAPHICS/ACCUPRESS REORDER NO. A15424

ANDROS BENCHES

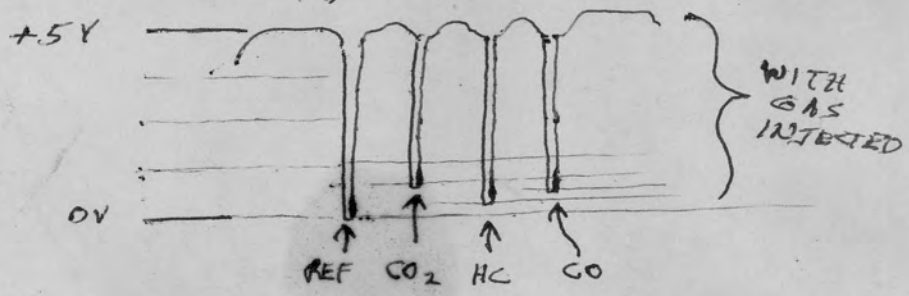
- MOST IMPORTANT CHECKS FIRST:

1) CHECK VOLTAGES AT A1J4 = PIN 2 = +15V
3 = -15V
10 = +7V
11 = -7V

2) CHECK 3 CAPACITORS ON SIDE

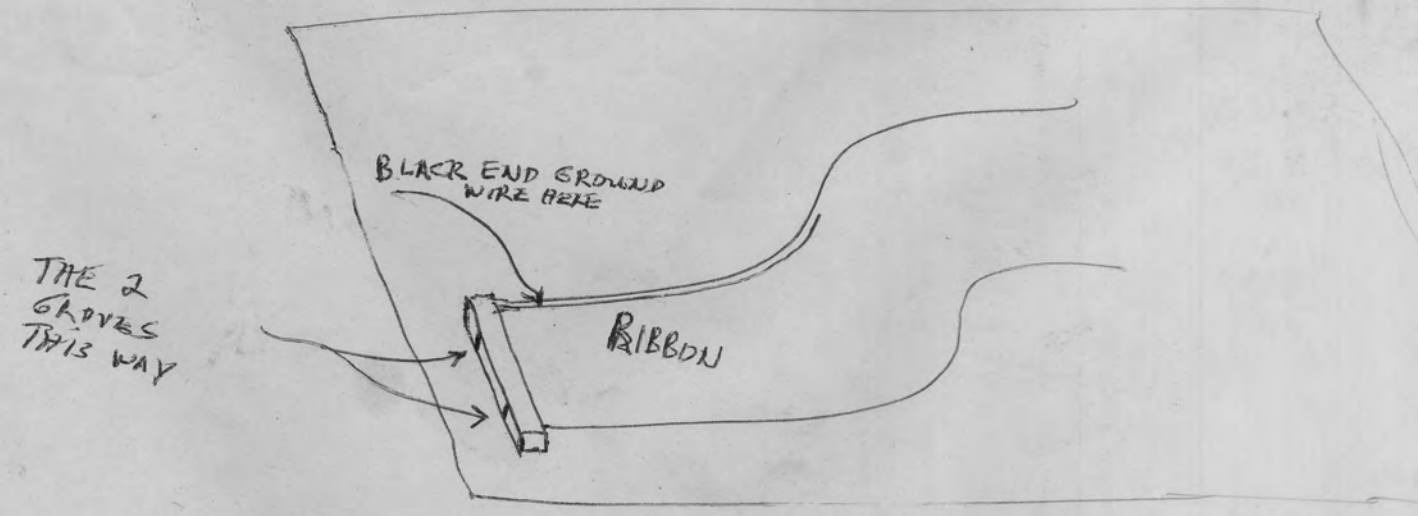
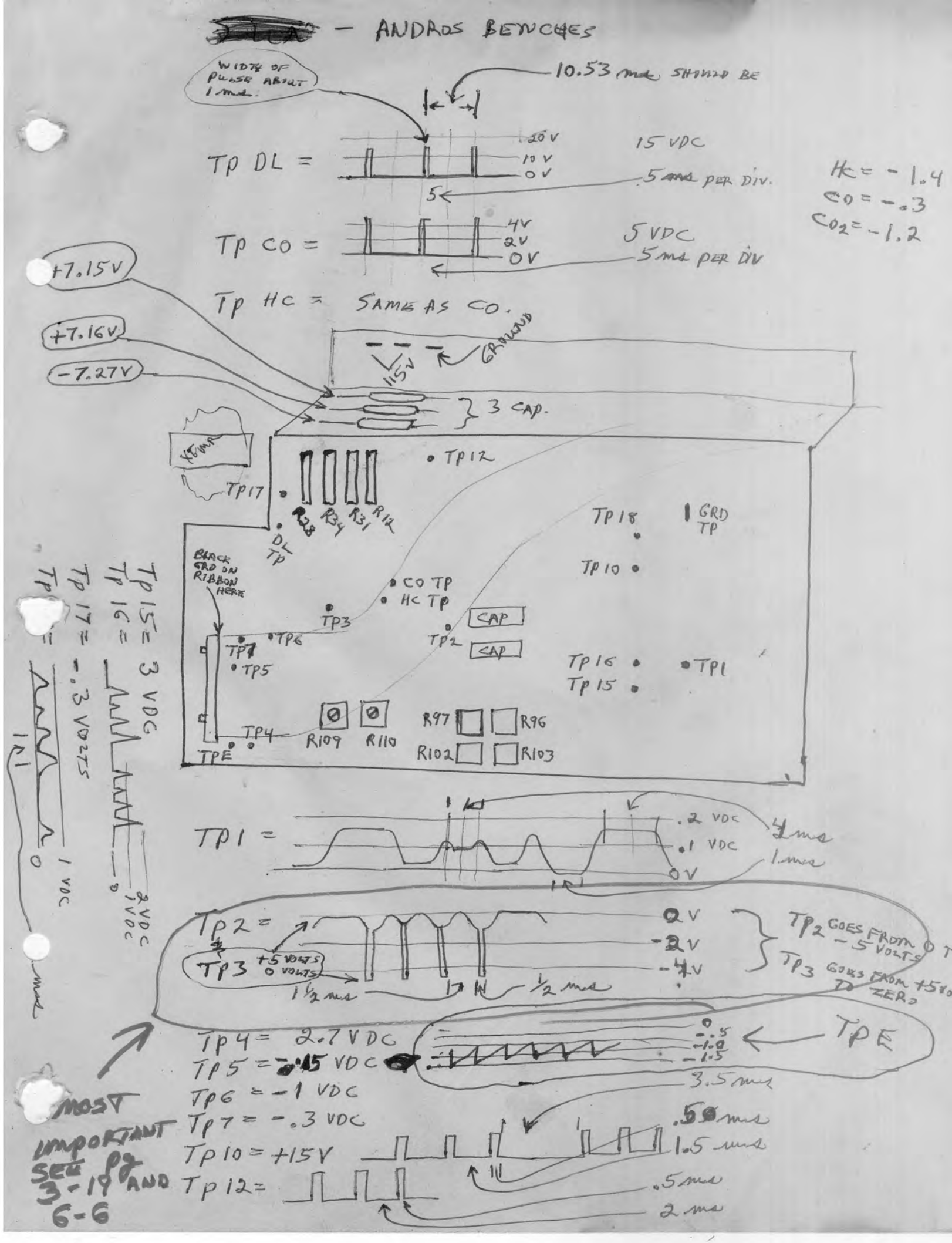


3) CHECK TP3 WITH SCOPE
SEE PG. 3-19 & 6-6 IN ANDROS BOOK



WITH NO GAS ALL POINTS SHOULD BE SET ON 0 LINE

USE R28, R34, R31 ON MAIN, TOP, PCBA. (REF, HC, CO_2, CO)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